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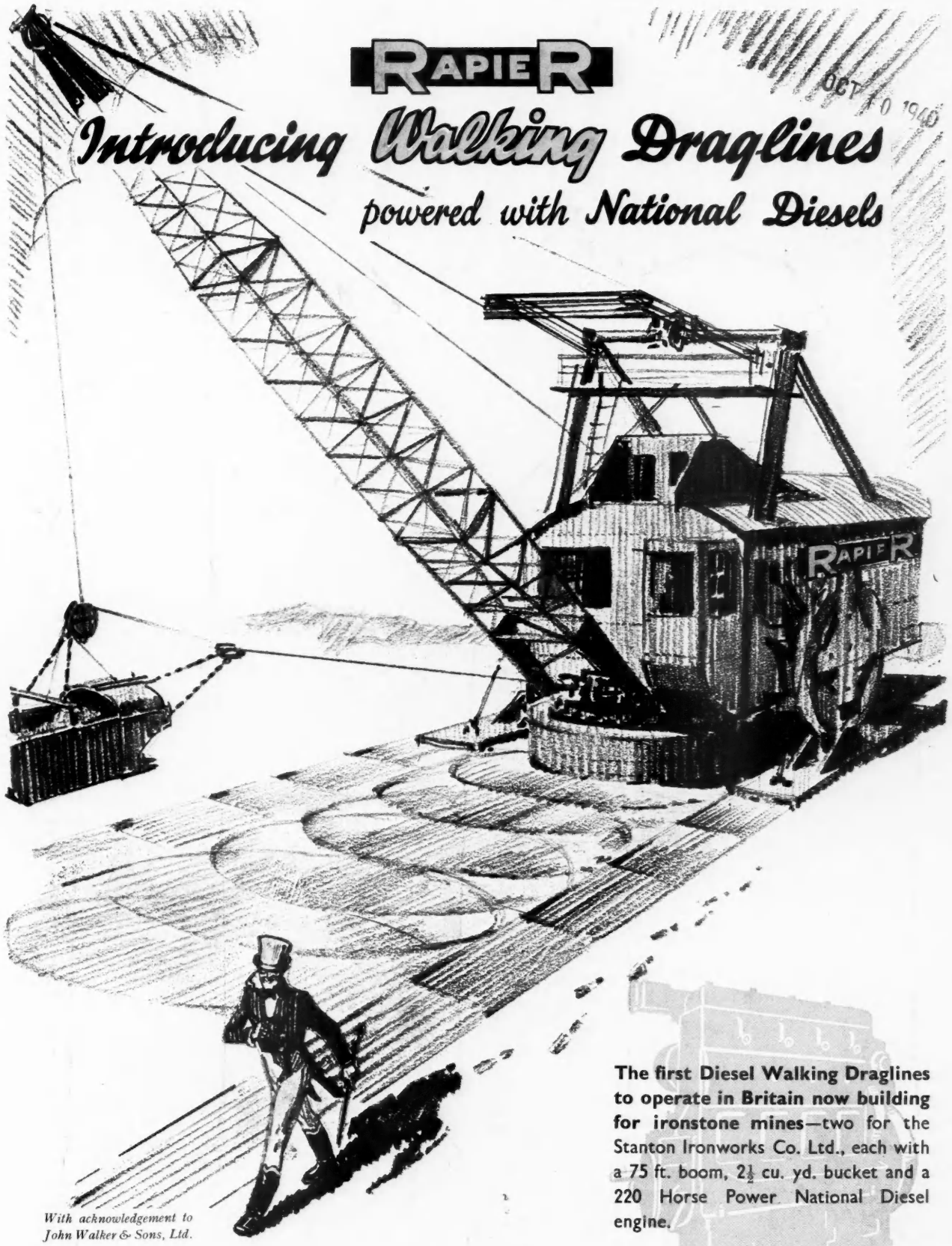


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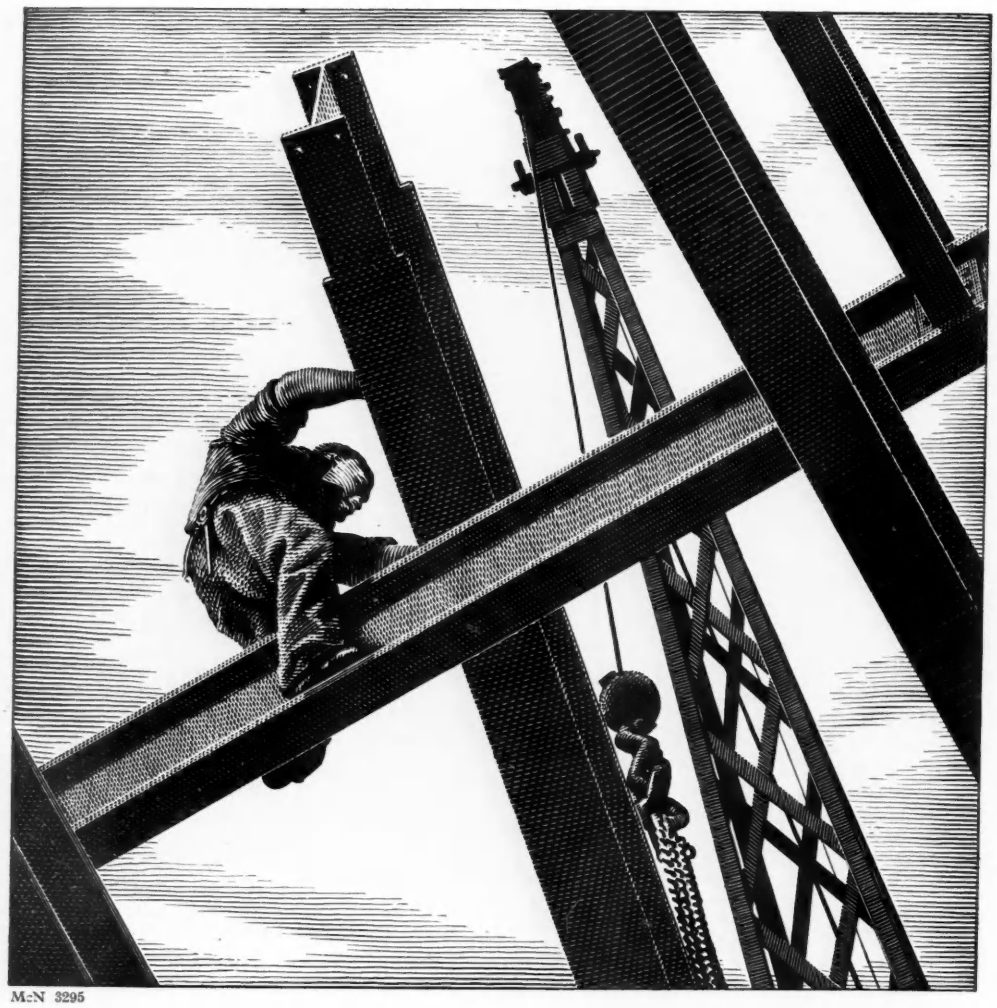

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# A Seven-Day Journal

## Factory and Fire Watchers

ON Saturday, September 21st, it was officially announced that the Minister of Home Security had made an Order under the Defence Regulations providing that a fire watcher shall be present at all times in all premises in which more than thirty persons work. This Order applies in addition to any premises, whether or not more than thirty persons work therein, the whole or any part of which is used as a warehouse of greater capacity than 50,000 cubic feet, and any saw mill or timber yard containing more than 50,000 cubic feet of timber. The Order does not apply to a warehouse when it is empty or to premises which form part of any mine or quarry. During the period in which a hostile attack is in progress in the vicinity or an air raid warning is in operation, the person who has undertaken to act as fire watcher must be in readiness to attack an outbreak of fire and summon assistance, and to use such fire-fighting appliances as may be available. The person responsible under the Order for seeing that it is carried out is the occupier of the premises. Any two or more occupiers of different parts of the same premises may arrange to provide one fire watcher for the whole building. On the same day it was further announced by the Ministry of Home Security that arrangements had now been made for the training of instructors who will then conduct local courses for factory watchers in each Civil Defence Region. It is intended that the arrangements for these courses shall be made locally, and employers are requested not to make applications for their watchers to be trained unless and until such applications are invited. No time will be lost in setting the local courses on foot. Meanwhile, schemes for working after the sirens should be carried forward with the best watchers available.

## Railway Signal Lights in Air Raids

ATTENTION has been drawn from time to time to the possibility that during air raids the lights of railway signals may prove of some help to the enemy. In reply to such criticisms a statement has recently been issued by the Ministry of Transport dealing with this matter. With regard to the brilliance of railway colour light signals, the Ministry's statement says that the beam is very narrow, and that from a normal flying height the lights are quite invisible. This fact is explained when it is recalled that all signals of this type are most carefully adjusted to be in exact alignment with the driver's vision. Quite recently the signals on a section of line in the London area were inspected by an officer of the Ministry of Transport. He reported that none of the signals appeared to be tilted upwards, and that had they been so tilted there would have been immediate complaints from drivers. A committee, composed of representatives of the Air Ministry, the Home Department, and the Ministry of Transport which investigated the problem in 1938, reported that if the signals were fitted with a 2ft. hood no material assistance would be given to enemy aircraft at the height at which they normally fly. These hoods have been fitted to all such signals. Tests carried out by the Air Ministry have confirmed the findings and suggestions of the committee.

## The Repair of Aircraft

IN a message to the Repair Organisation of the Ministry of Aircraft Production, scattered throughout the country, which was issued by Lord Beaverbrook on Thursday evening, September 19th, the highest praise is given by the Minister to the magnificent work which is being done by the organisation. The highest praise is merited for the night and day shifts, the indifference to air raids, the maintenance of output in the face of danger, and the dwindling record of "time out" in the shelters. In one organisation, says Lord Beaverbrook, only 15 min. of valuable time was lost last week. In another organisation bombing on a vast and grievous scale, which was accompanied by a long roll of casualties, only meant two days of suspended production. In giving public recognition to the work of all engaged in the repair of aircraft and aircraft engines, Lord Beaverbrook makes reference to the results of the organisation for the week ended Saturday, September 14th. In that week, he says, the output of the repair organisation engaged on operational types of aircraft, including both bombers and fighters, was in excess of all types of aircraft lost and destroyed in battles and in accidents. In addition, the organisation had, he said, sought out many inventions.

## Salvage of Old Dry Batteries

WITH the setting up of a new industry to recover battery materials from old torch and high-tension batteries, the Salvage Department of the Ministry of Supply has found a useful outlet for materials which in pre-war times were often difficult to dispose of. Already several firms are recovering from these old batteries useful materials for our war effort. From the beginning the Ministry has given the firms every encouragement, and recently a circular has been sent to local authorities pointing out the importance of the materials which are made available by this new war effort. Already the demand for old batteries seems to be outstripping the present supply. One firm which is at present dealing with 10 tons of batteries per week, obtained from local authorities, states that it could use 100 tons if these were collected. It is pointed out by the Ministry that 100 tons of old batteries will yield 10 tons of zinc, 3 tons of carbon rods, 10 tons of pitch, 3 tons of pulverised carbon, 1 ton of brass and copper, 10 tons of cardboard, and 50 tons of a mixture of graphite, manganese ore, and beconite. The brass and copper are extremely useful in munitions and other work, the zinc can be utilised for coating utensils, and the graphite is useful for machine lubrication, while there are evident uses for the carbon, cardboard, and manganese ore. Final arrangements have yet to be worked out by the local authorities for the collection of old batteries, but it is requested by the Salvage Department that batteries put out for collection by the dustman should, if requested by the local authority, be wrapped separately to keep them clean. They should not be included with ordinary rubbish.

## British Trade with South America

IN a Journal note of September 13th we recorded the decision of the United Kingdom Commercial Corporation to send two of its representatives to South America with the object of stimulating the export trade of the United Kingdom and the countries of South America. On Monday last, September 23rd, it was announced jointly by the Foreign Office and the Board of Trade that His Majesty's Government had decided, with the approval of the Governments concerned, to send a special mission to South America under the leadership of the Marquess of Willingdon, who will have the support of Sir Horace Rumbold and the Hon. R. H. Brand. The mission will also include Lord Forres, an executive member of the Export Council, and the following representatives of important industrial and export interests :—Sir Walrond Sinclair, Sir Granville Gibson, Sir Ernest Johnson, Sir Kenneth Lee, Mr. J. A. Burns, Mr. Herbert Hey, Mr. H. McGill, Mr. H. S. Mackintosh, Mr. C. S. Richards, and Sir Jonah Walker-Smith. The mission's object will be to explain to the Governments of the countries visited British economic policy in the circumstances of the war and to promote the export trade of the United Kingdom so far as conditions allow. It is not intended, however, that the mission should undertake the negotiation of commercial agreements.

## A Swedish Inventions Board

IT is reported from Sweden that the isolated condition of that country, which is now cut off from many trade routes and contacts with other countries, has caused the Swedish Government to give attention to Swedish inventive genius, by setting up a Swedish Inventions Board. By this means it is hoped to foster and develop valuable contributions towards the solution of the many problems of the present time. The Chairman of the Board is Director-General Helge Ericson, of the Swedish Telegraph Office. The functions of the Board are stated to include the promotion and utilisation of inventions and technical ideas, in so far as they can be realised with the necessary dispatch, and without unreasonable cost. Special attention is to be paid to ideas which are of value for the national economy and the defence of the country. One of the first tasks of the Board will be, it is understood, to give consideration to the utilisation of Swedish raw materials in any of the proposals which may be submitted to it. Already several plans have been submitted, which will enable the Board to start its work. The Board is composed of three members, who have been appointed by the Swedish Government, but power is given to the Board to call upon the services of outside collaborators and advisers when assistance is desired in judging the merits of specific cases. It is further announced that all documents relating to inventions will be kept secret and that all matters relating to inventions and ideas submitted will be dealt with in the simplest and most expeditious manner.

## New National Scrap Metal Survey

ON Monday, September 23rd, it was announced by the Minister of Supply, Mr. Herbert Morrison, that arrangements have been completed by the Ministry for a new and comprehensive survey of the nation's scrap metal, in order to assess and record all the larger sources of potential scrap metal. The new survey, it is announced, will cover every condemned bridge and derelict building, also every abandoned mine and quarry. It will include such sources as disused steel towers, mine and railway tracks, and many large structures which, no longer in use, nevertheless contain valuable iron and steel. On previous occasions Mr. Morrison has stressed the vital need for a full and continuous flow of scrap iron and steel to the furnaces of the country. To-day as a result of the efforts of local authorities and the general industry, supplemented by the work of enthusiastic voluntary organisations, a vast amount of scrap metal has been brought to light and assembled. The needs of the future are such that the problem is now to be tackled more actively, with the object of making a 100 per cent. collection. While there are reserves in hand, steps must be taken to increase these reserves, and Mr. Morrison expresses his confidence that the new survey about to be undertaken will reveal a vast potential tonnage of material. Bearing in mind the intimate local knowledge and skill which are needed in order to locate the material needed, it has been planned to conduct the survey with the collaboration of all the appropriate officers of the local authorities throughout the country. In view of the desirability of testing carefully the method of conducting the survey and determining the tonnage likely to be secured, the survey is to be launched in the two representative counties of Somerset and Glamorgan. Loyal and enthusiastic support has been given by the responsible local government officials in these counties. As and when needed, other counties will be brought into the survey.

## A New Source of Power

AT the recent bicentennial conference of the University of Pennsylvania, which took place in Philadelphia, it was reported by Professor Enrico Fermi, of Columbia University, that physicists in the United States of America and in Japan have succeeded in creating out of ordinary uranium a new element with potentialities as a source of power which are even greater than those of uranium. One pound of uranium U-235 has, it is recorded, been found to be equivalent as a potential power source to 5,000,000 lb. of coal or 3,000,000 lb. of petrol. The new element has been called U-237. It is made by bombarding ordinary uranium U-238 with fast neutrons, the elementary particles of matter which carry no electrical charge. It was first created in America in the laboratories of Professor Ernest O. Lawrence, and almost at the same time in Japan by the Japanese physicist Nishima. So far only infinitesimal quantities of the element have been produced. It is hoped, however, to produce larger quantities of U-237, when the new giant cyclotron, now being constructed at the University of Columbia by Professor Lawrence, is completed in three years' time. This apparatus will weigh close upon 4000 tons, and when in operation will enable uranium to be bombarded with atomic projectiles of between 100,000,000 and 200,000,000 volts. It is reported by exiled scholars from Germany that nearly 200 leading scientists in Germany have been ordered to concentrate all their efforts to release the atomic power in U-235 and now possibly U-237. It is also pointed out in connection with this work that the German scientists have at their disposal not only their own facilities but the Copenhagen Laboratory of Professor Niels Bohr, and, in Paris, the equally famous laboratories of the Radium Institute, where experiments on uranium have been carried on by Madame Eve Curie-Juliot and her husband Monsieur Frederic Juliot.

## Enemy Merchant Fleet Losses

IN a statement made on Tuesday, September 24th, the Minister of Shipping reviewed the shipping position as revealed by enemy losses and the undiminished strength of the British Merchant Navy. He said that about one-sixth, or more probably a fifth, of the merchant fleet with which Germany started the war was captured or sunk, while a further sixth part had taken shelter in neutral ports. In other words, Germany disposes of only about two-thirds of her tonnage, and as is well known, her ships are now restricted to a game of General Post in the Baltic and some burglarious trips, clinging to a limited part of the European coast line. Germany has, of course, obtained control of some of the shipping of the countries she has invaded, but these ships are also limited to Baltic trade or coastal sorties, if not locked up in some neutral port. Italy came into the war about three months ago, and in preparation for war had so arranged her ships and sailings as to reduce, so far as she could, the number which would be exposed to capture by the British Navy. Nevertheless, one-quarter of Italy's merchant fleet was captured, sunk, or taking refuge in neutral ports, and the balance was confined to hopping precariously to ports not excessively distant from the Fascist Fatherland. British merchant ships had, by contrast, unceasingly sailed the oceans of the world throughout the year of the war. Despite attacks by submarines, raiders, mines, and more recently by E boats, we had lost by enemy action only about 8 per cent. of our pre-war merchant fleet. Captures, new building, and transfers from foreign flags had brought us reinforcements in excess of our losses. The great fleet of British, Allied, and neutral ships was bringing us between four and five million tons of imports a month.

# Further North American Locomotive Experiences

By EDWARD H. LIVESAY

No. II

(*Continued from page 181, September 20th*)

### THE "400" DIESEL-ELECTRIC TRAIN

AMERICAN railways have been very heavily hit by road competition during recent years. Fast buses link every town of importance, offering low rates, attracting passengers away from the railways by this and many other a seduction. Nowadays, too, most people have their own cars, and, the highways being good, there is a very general tendency to go by road instead of rail, even over long distances. Everything possible is being done by the railways to win back the travelling public, and one of the means adopted to this end has been the provision of super-fast trains, both steam and diesel, with luxurious equipment and smooth-running, air-conditioned cars. It is one of the latter trains, "The 400," with which this article is concerned.

This train runs between Chicago and Minneapolis, a distance of 407 miles, over the Chicago and North-Western Railway, making the journey in 405 min., with eight stops. The actual running time is, of course, less than this, and average speeds over certain intermediate stretches are very high. Until recently, "The 400" was steam hauled, and was then the fastest steam train in the world, averaging 75·8 m.p.h. over the 78·3 miles from Chicago to Racine. In its present diesel form it has lost this pride of place. Nevertheless, it remains in the front rank as one of America's leading trains, and I was glad to have an opportunity of travelling in the cab, all the more as it was my first experience of diesel propulsion.

The first division of the route, over which I made the return trip, is from Chicago to Milwaukee, 85 miles; two stops are made, at Evanston, 12 miles, and Racine, 70 miles. The track follows the shore of Lake Michigan fairly closely and is really a water-level route, so gradients are not serious; in fact, I do not know if there are any worth noticing If there are, I must have overlooked them, as it was easy to do on a train with such an obvious contempt for inclination as "The 400." This division did not strike me as being very suitable for ultra-high speed, as it first passes through the suburbs of Chicago and then through a succession of manufacturing towns. There is little open country, curvature is quite common, and I was almost appalled to find that—but I will reserve this revelation for the present! Automatic colour-light signals are installed, trains running on the left-hand track, not the right. I believe this is the only railway in America to be worked this way, the explanation given me being that it was built with English capital, and certain English ideas came with the money—this left-hand running was one of them.

So much for the route; now for the machine. Fig. 3 shows it to be made up of two similar units, each running on two six-wheeled trucks, four of the axles carrying nose-suspended motors. The current for these comes from direct-coupled generators, driven by twelve-cylinder V type diesel engines, of 1000 H.P., two being installed on each unit. The total horse power therefore is 4000. The two units are similar, each with its cab, so the locomotive can be run in either direction. There is a separate generating plant for lighting in each unit, and similarly an oil-fired boiler for heating. A passageway round the engines and vestibule connection between the two units give the enginemen access to most of the machinery at any time. There is such a mass of gear that it is impossible to describe it fully in an article of such limited length as this. A very cursory outline must suffice. But after an inspection of the twin engine-rooms it is easy to understand why these diesel trains cost about twice as much as an equivalent steam outfit. The latest type of American express engine built for high power and speed costs about £35,000; its diesel opposite number approximately double that sum.

The streamlined train consisted of ten eight-wheeled, non-articulated cars, with electro-pneumatic brakes and shock-absorbing trucks. A quick walk through showed the keynote to be simplicity, both with regard to the fittings and the decoration. All elaborate and florid ornamentation was taboo; the colour scheme was a quiet, restful pearl grey, with plentiful chromium plating. All superfluous weight has been cut out by the use of aluminium and light alloys, and the welding of joints. Air conditioning goes without saying. I did not travel in the cars at all—the engine was much too interesting. I can well believe their riding is pluperfect, but if it is any better than the engine's, it must be similar to the enthusiastic old lady's conception of aerial locomotion—like "boring through the air in a saloon." What could be more delightful than that?

FIG. 3—CHICAGO AND NORTH-WESTERN RAILWAY DIESEL-ELECTRIC LOCOMOTIVE

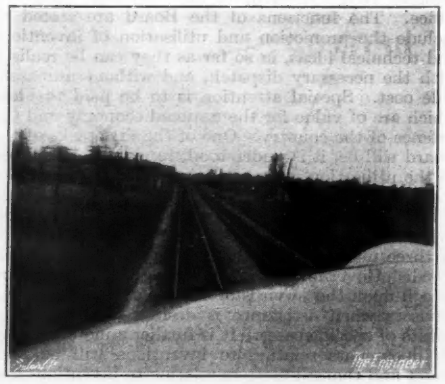


FIG. 4—VIEW FROM CAB

I picked up the train at the Chicago terminus—Madison, I think; apologies if I am wrong. Naturally the cab was very different from that of a steam locomotive; it was a spotless compartment, with two revolving armchairs, a couple of controls in front of the engineer's, four dials, and that is about all. Engineer Miller sat on the right, myself on the left—after the former's son, a most likeable University student, making his first trip with his father, had courteously surrendered the left-hand seat to me—the two enginemen making periodic appearances in the cab, to stand between us at the back. We were shut off from the engine-room by a nearly soundproof door, so that except for a slight hum from the gears below the floor and a very muffled rumble from the engines, there was practically no noise whatever—it was not necessary to raise one's voice at any time. The engineer's controls were (1) controller with dead man's foot pedal; (2) brake; and (3) whistle. A speed indicator was in front of him, and two dials—(1) fuel supply and (2) water heater—in front of me. I cannot remember anything else, though I may have overlooked something of minor importance. The windows, with motor-car type wipers, gave a perfect look-ahead over the projecting prow, as Fig. 4 shows. Everying was novel to me; I felt I was in for a most interesting experience.

"The 400" pulled out punctually at 3 p.m., in a drizzle, accelerating smoothly and very fast, more like a motor-car than a train, and far more quickly than a steam train could have done. There are several curves outside Madison Station, and these were taken with an easy and serpentine grace that it was a delight to feel. Switches and crossovers were imperceptible, and when we changed over from the outer, slow track upon which we had started to the middle fast metals, the transition was entirely shockless and almost unnoticed. I was so fascinated by the silky motion of the engine and the quiet comfort of the cab that several miles were covered before I could orient myself to these strange surroundings. I just sat in my armchair absorbing impressions. At the fifth milepost the engineman said: "What speed do you make it?" I hazarded 40 m.p.h. He smiled: "Guess you're a bit out; look at the indicator." It said 65! I felt humbled; after all my experience of road and rail to make such a bloomer as that. But the motion was so deceptive; in fact, there wasn't any motion; there was no feeling of wheels rolling on rails—we were gliding, not rolling along.

The first few miles had been covered fairly cautiously; the train was threading the heart of Chicago, and speed was out of the question, but about 7 miles from the start a straight was entered, and I felt the engine accelerate like a car. In a few yards the indicator was showing 80 m.p.h. The riding was absolutely perfect, without a trace of roughness or vibration; just a smooth, humming flight, with only an occasional trifling side sway. The first considerable curve to be taken at speed showed up ahead, and we hit it at 85. But no, "hit" is the wrong word to use. We glided into it rather, and if I had not watched it coming and seen it disappear under the prow, I should not have known one had been negotiated.

A stop at Evanston was made at 3.13½—12 miles in 13½ min., with one slowing to 30 m.p.h. and cautious running for most of the distance. The restart was at 3.14½, and again the tremendous surge forward, with its sense of unlimited power, delighted me. Acceleration plus—the seat pushed me in the middle of my back. Switches and crossings were swept over as if they were non-existent—seen, but not felt. The weather had now cleared, and the wiper came to rest. It had been flicking to and fro since the start, emphasising again the cogency of my admonitions in past articles that all locomotives should have some kind of window

cleaner. In spite of the rain, the look ahead had been good; now the sun-lit track flowed straight towards us, pouring smoothly away under the humming floor. The projecting prow looked much like the bonnet of a powerful car, but there is nothing under it, except a locker.

After Evanston a clear run lay ahead to Racine, and the speed mounted higher. My pad says: "Took curve at 90 m.p.h., and over switches—both imperceptible. And this through towns with no fences and unprotected grade crossings." There is the "revelation" I forecasted in an earlier paragraph! There we were, doing upwards of 100 m.p.h. through a succession of towns, yet most of the track was unfenced, and many level crossings were unguarded, without even gates. With all the desire in the world to approve and praise, I really cannot do either in this connection. According to the strip map, we passed through fifteen sizable towns in the 85 miles to Milwaukee, plus a good piece of Chicago. The train was one of the fastest in the world, very silent, and capable of tremendous acceleration. There were "blind bends" galore, yet unfenced streets and roads both paralleled and crossed the metals. Anyone or anything might wander on to them at will. Obviously chances were being taken. Some nit-wit would try to "beat the train to the crossing," a truck might stall just as the flyer approached, any one of a dozen things might happen and a wreck result. I pointed this out to the crew, and they agreed—it might. As a matter of fact, it already had! I devoutly hoped it would not on this occasion, and was whirled onwards, faintly apprehensive—I was in front. No, candidly, "We were not pleased; we did not approve."

Still the speed rose. At Fort Sheridan it was 95, a slowing shortly after bringing out the perfection of the brakes, which acted with great power and extreme smoothness. Deceleration was very rapid, feeling just as it does in a car; there was a tendency to fall forward and brace oneself against something. The deep-toned air hooter sent out its warning incessantly—I hoped due attention would be paid to it. Nearing Lake Forest we took a considerable bend at 97 m.p.h., as smoothly as a racing car on the banking at Brooklands. I asked for 100 m.p.h., and twice we nearly got it, but something always just prevented it. The cab was very quiet; only a muffled drumming came from the engine-room and a musical whine from the gearing beneath the floor, neither at all obtrusive. But when the door into the engine-room was opened, a roar burst in; upwards of 4000 H.P. was being generated in there.

Whirling through Waukeegan, with Lake Michigan showing blue on our right, at 90 m.p.h., I again asked if 100 could be worked up to, as I wanted to take a picture at this speed—I might never get another chance of such a snap. Besides, it felt lovely; like a foretaste of Paradise—floating through space, sitting on a piece of rainbow stuffed with cloud. Really, it was just like that. And such an utter contrast to an energetic but somewhat ancient "Pacific" I had ridden out of Toronto a few days before, which shook all my machinery loose. The diesel was Heaven—the other was Hell. Shortly after we sailed through Zion (which is probably what put these celestial similes into my mind). Do you remember "The Great Profit," Dr. Alexander Dowie, in the early years of the century? Zion was where he hung out his shingle—and raked in the dough. Unlike the Profit, we were on the straight and level here, and I was told to get my camera ready for the Picture of the Century. Asking the engineman to sing out the readings, I stood up with the camera close to the window. The song of the gears took on a rising note; "94" came the hail, "96–98–100!" Click. Fig. 4 is the result. Not content with this, the speed continued to rise, 103 being touched before the brakes went on for a curve, at once dropping sharply, followed by rapid acceleration again. At these high velocities, the engine simply floated over the rails, like a Rolls-Royce over a good road. Only by looking out of the side windows, and seeing the telegraph poles flicking by could one gauge the speed at which we were moving. This was the first time I had travelled at 100 m.p.h. on land, and now I have a permanent pictorial record of it. The nearest approach to it was on the footplate of "King William III," hauling the "Cornish Riviera Limited," when 92 was touched near Lavington (THE ENGINEER, April 14th, 1939).

Again quoting from my pad: "Cannot get used to the absence of fences—high speed does not seem safe." It still does not. Fig. 4 will "witness if I lie." No fences show there, but one of those beastly ungated crossings does, in the middle distance, apparently at a flag station. I was told that once "The 400," when steam hauled, hit a car at 100 m.p.h., and ran a mile before coming to a stand, only the engine's leading truck being derailed. Its luck was in that day. I hoped mine would continue to be. The Racine stop was made at 3.52½ p.m., the 50 miles from Evanston having been made in 38 min., at an average speed of 79 m.p.h.

Getting away at 3.53½, only 23 miles to Milwaukee remained. Acceleration was extraordinarily rapid, the speed rising to 104 before the next station, S. Milwaukee, was reached. The last 5 miles were very tricky, round frequent curves, some of them "blind," over crossings and switches, but the train, handled like a car, came to a stand in the depot at 4.13 p.m., 2 min. early. I had four hours to wait until the return trip, in which to meditate, rest and take refreshment, which, of course, included a draught of "the beer that made Milwaukee famous." The town was passed up—I was told it had a strong German element, which, I felt, would inevitably tend to make it a stench in my nostrils.

Entering in the reverse direction, "The 400" pulled into Milwaukee late, leaving again at 8.10 p.m., 10 min. behind time, in fading daylight, and soon running into rain. As it was getting dark—the 8.10 p.m. was daylight saving time—and I hankered for some *real* speed, 104 having merely whetted my appetite, I pretended disappointment with that quite respectable figure; surely "The 400" was capable of something better? "I understood 125 is the limit, and we are a bit late, aren't we? What about making it up?" Machiavellian, what? To some degree it worked; nearing Racine, along the same straight where 104 had been reached in the afternoon, I gleefully watched the indicator needle go up to 110 m.p.h. But before it could rise any higher speed had to be cut for passage through Racine; no stop was made there on this run. But "'twas enough—'twould serve." It may have been done on three engines, too, as the late arrival at Milwaukee had been due to a split in one section of radiator, and an engine had been cut out for that reason. I am not sure if the idler had come into action again.

Darkness brought the headlights into play; there are two, as Fig. 3 shows. The lower is the usual fixed pattern, but the other is a "Mars," which swings the beam continuously from side to side of the track in a "horizontal figure-eight" manner. It is intended to attract extra attention, and make people realise something out of the ordinary is coming. It probably does so—and doubtless scares inebriates into realising they have loaded beyond the Plimsoll line, too.

Waukeegan passed at 8.47—49 miles in 37 min., average 79·5 m.p.h.; the Evanston stop was made at 9.07—73 miles in 57 min., average 76·9. Away again at 9.11, the final 12 miles were covered in 14 min., and "The 400" came to a stand in Madison Station at 9.25 p.m., still 10 min. late; nothing had been made up. Undoubtedly the two runs had provided plenty of material for thought.

"Comparisons are odious," perhaps, but inevitable when one makes one's first run on a diesel after thousands of miles on steam locomotives. I thought of the latter, hammering and pounding along the rails, even when in the best of condition; often nosing and lurching round curves, hitting them with a blow and a wrench that spell wear and tear in both engine and permanent way—and then of "The 400," spinning smoothly along, snaking round curves with easy flexibility, silent, sinuous, smokeless. The tardy, grudging acceleration of the steam train—the quick, responsive surge forward of the diesel. The grinding brakes of the former, often ending in a shuddering, jerky stop—the silky, determined grip of the latter's electro-pneumatic equipment. Impossible to avoid thinking: "Surely this must be the writing on the wall—the long day of the steam locomotive of basic design seems drawing to a close." It will be noticed that I have qualified the query: "The steam locomotive *of basic design*." High-speed, multiple-unit, gear-driven machines, perhaps they have a longer future, but the present basic type—I wonder.

Some readers may quarrel with my ideas as to the possible shape of things to come; some will know that the ideas are mistaken. I do not claim to *know* what will happen, and do not wish to be dogmatic—this ought to let me out. As the negro preacher said, concluding his sermon on Wisdom: "It ain't the things you don't know what gets you into trouble; it's the things you know for sure what ain't so."

The first cost of these diesel trains greatly exceeds that of their steam competitors, but this is being offset as far as possible by keeping them running hard and standling idle as little as possible. "The 400," for instance, makes the return trip, Chicago and Minneapolis, daily, over 800 miles. If a diesel engine fails seriously, it is lifted out and a spare installed—the locomotive is not laid up. As to the probable life, frequency of overhaul, cost of running, &c., of this type of motive power, Mr. Michael, the C.M.E. of the Chicago N.W. Railway, says that "The 400" has only been in service about a year, too short a period to enable him to speak definitely on the subject.

The question may be asked whether 110 m.p.h. seemed to represent anything like finality on a 4ft. 8½in. track; was the safety limit approached? Decidedly not; I do not think that 150 m.p.h. would have been dangerous on the straight, and 100 round super-elevated curves, over a track in first-class condition. This seemed to be good, but nothing out of the way. Had it been entirely fenced in and protected, as it certainly should have been for high-speed running, and every level crossing eliminated, "The 400" could easily have averaged 100 m.p.h. where it actually did 80. But those ungated crossings—they stick in my gizzard! And merely gating them probably is not enough for super high-speed work; some nit-wit sooner or later would crash the gates, and park the wreckage on the metals just as the flyer came along. Only under and over-bridges solve the problem. A final point—a diesel electric locomotive is without doubt much easier on the track than a steamer, as hammer blow, racking, and nosing, and so on, are all practically washed out. For that reason alone, much higher speeds are perfectly feasible than with the steam locomotive of basic design.

It is clear from this account that I was very much impressed by my experience, but I am inclined to think that familiarity, though it might not breed contempt, perhaps would induce boredom. Once the novelty of the speed and smoothness wore off, as they probably would, there would not be much left. There is so much of interest to note in a steam locomotive's cab—there is very little in a diesel's. But, after all, handsome is as handsome does, and the diesel's doings were very good-looking indeed. If I became too critical—well, I was brought up on steam!

I am much indebted to the courtesy of Mr. Michael, the C.M.E. of the Chicago and N.W. Railway, for permitting me to make these runs, and for the information he gave, and to the crew, whose kindness added so much to the pleasure of them.

*(To be continued)*

## Graphite from Madagascar

As a producer of flake graphite, Madagascar leads the world, says the *South African Mining and Engineering Journal*. Moreover, the island produces a large quantity of graphite dust. In 1917 the total graphite output was 27,000 metric tons. Production decreased after the World War; exports in 1932 aggregated only 2146 tons. However, rearmament of European countries caused a revival in the exploitation of graphite, exports of which in 1938 totalled 13,433 tons; and while they decreased slightly in the first eight months of 1939, there was a subsequent rise in production, which points to a greatly increased output of both flake graphite and graphite dust in ensuing months.

Early in February, 1940, the Governor-General of Madagascar visited the graphite works of the Société Générale des Graphites at Tsarazafy, the oldest in existence in Madagascar, which are now being exploited. In 1908 the graphite output of the company was 160 metric tons, advanced to 475 tons in 1913, to 600 tons in 1918, and to 905 tons in 1924, during which year production was at its peak. In 1926 the quantity produced dropped to 705 tons. A crisis in the operation arose thereafter, and the deposits were idle until the last few years. However, in 1938, 247 tons were produced, and in 1939 235 tons. In January, 1940, the graphite output of the Société Générale des Graphites for the month reached 97 tons.

The deposits, which are easily accessible, are on the left bank of the Ikopa River. They are covered by unproductive stratum that ranges in depth from 2 m. or 3 m. to 7 m. or 8 m. The graphite content varies, but is always very rich. The average yield is 1 ton of "débourbé" (cleaned mineral) containing 49 to 50 per cent. carbon to 3 tons of mineral; 4½ tons of débourbé yield 1 ton of standard flake graphite containing 90 per cent. carbon and 1 ton of dust containing 80 to 86 per cent. carbon; 7 tons of basic mineral produce 1 ton of graphite.

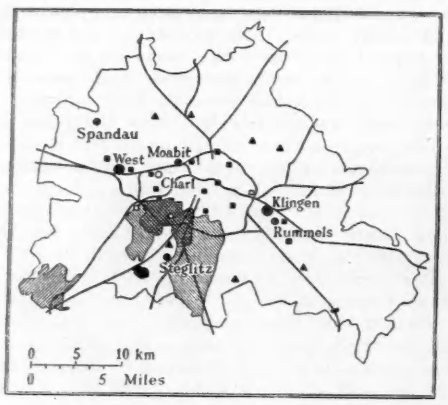
# Air Force Targets in Germany

No. V

(*Continued from page 135, August 30th*)

### Two Berlin Power Stations

DURING the last few weeks repeated attacks have been made by the Royal Air Force Bomber Command on important military targets in the City of Berlin, and in the district immediately surrounding that city. Among other targets which have suffered severe damage, reference is made in the communications of the Air Ministry to two power stations on the supply network of the "BEWAG," or Berlin Elektricitäts Werke A.G. The stations to which reference is made are the famous Klingenberg power station at Rummelsburg, on the eastern arm of the River Spree, and the newer West power station, on the lower Spree, to the west of the city. Although in recent years the amount of bulk supply taken from the neighbouring Märkische Elektricitäts undertaking and the Elektrowerke network, served by lines from the Zchornewitz, Trattendorf and Lauta




**Berlin Supply Network**

power stations, has increased, the size of the principal power stations of the "BEWAG" has not substantially increased, and the figures below quoted by Ministerialrat, I. W. Van Heys, in his volume on Deutschlands Elektricitäts Wirtschaft of 1931, three years before the Berlin electricity company's fiftieth year celebrations in 1934, may be taken as indicating the disposition of the various sources of supply. The accompanying map shows the arrangement of the supply network.

*Power Stations in the Berlin Network*

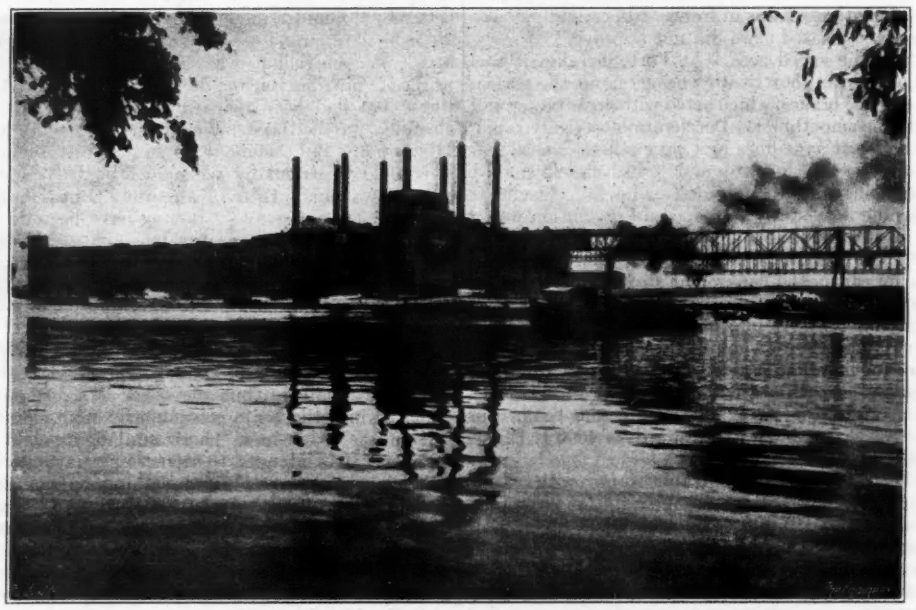
| Name of Station | Normal Output in kW. | Maximum Output in kW. |
|---|---|---|
| Klingenberg | 240,000 | 270,000 |
| Charlottenburg | 50,000 | 54,000 |
| Charlottenburg Steam Storage Station | 40,000 | 50,000 |
| Moabit | 69,700 | 81,000 |
| Rummelsburg | 65,800 | 79,600 |
| Oberspree | 38,950 | 44,450 |
| Steglitz | 6,000 | 6,600 |
| Spandau | 43,000 | 56,000 |
| Weissensee | 1,500 | 1,500 |
| West Power Station | 228,000 | 228,000 |

### Klingenberg Power Station

The Klingenberg power station, a south view of which is reproduced herewith, was put into commission by the Berlin electricity company between the years 1926 and 1928. At that time it was noteworthy, not only for its size, but as being representative of the latest Continental practice in super-power stations, particularly those burning powdered coal as fuel. The site chosen for the station is to the east of Berlin, at Rummelsburg, on the bank of the River Spree. It was originally intended to call this super-station the Rummelsburg Station, but it was given its present name, as a memorial to the late Dr. G. Klingenberg, the well-known director of the Allgemeine Elektricitäts Gesellschaft, of Berlin, a recognised authority on the design of super-power stations, who was responsible for its construction.

The necessity for this new station was acutely felt already in 1924, when the peak load on the Berlin system had risen to 208,500 kW, compared with a total load of 142,000 kW in the previous year. That large increase in the demand for electricity was caused by the better industrial conditions which followed the stabilisation of the mark. The site of the station which was secured at Rummelsburg had an area of about 40 acres, and the intention then was to construct a super-power station with an eventual maximum capacity of 540,000 kW. The original plans which were drawn up made provision for the station to be built in two separate parts, half the ultimate capacity being provided immediately.

So energetically was the work proceeded with that although the first sod was only cut on September 15th, 1925, the first part of the power station was finished on July 30th, 1927, and 270,000 kW



**Klingenberg Power Station**

of turbo-alternators, with the boilers and coal-pulverising plant, and the necessary switchgear and transformers, was erected ready for service. Some idea of the magnitude of the undertaking will be obtained from the following dimensions of the first section of the power station :—

*Dimensions of the Principal Buildings*

| Building | Length in ft. | Breadth in ft. | Height to eaves in ft. |
|---|---|---|---|
| Main turbine room | 478·3 | 84·1 | 82·7 |
| Boiler house, each | 243·8 | 136·6 | 100·1 |
| House turbine room | 243·8 | 82·9 | 68·4 |
| Offices | 426·5 | 72·2 | 57·4 |
| 30,000 volt switch house | 459·3 | 59·1 | 63·0 |
| Powdered fuel mill house | 390·4 | 82·0 | 125·3 |
| Administrative block | 88·6 | 63·2 | 139·4 |

In the main turbine room there are three A.E.G. turbo-alternators, each with a designed maximum continuous rating of 80,000 kW. They are placed end to end, in line with each other. At right angles to the main turbine room and situated centrally with it there is a second turbine room, in which the three house turbines are housed. Like the main sets, these are also of A.E.G. design and manufacture, and they each have a rated capacity of 10,000 kW. This room also contains the A.E.G. boiler feed and other auxiliary pumps. On either side of this second turbine room is a boiler house containing eight boilers, so arranged that the central aisle of each boiler house runs at right angles to the main turbine room. The sixteen boilers each have a designed working pressure of 35 atmospheres, or 498 lb. absolute, with a final superheated steam temperature of 410 deg. Cent. The boilers are of differing designs and makes, the total heating surface of each being about 19,375 square feet, with a maximum rated steam output of about 80 tons per hour. All the boilers are fired with powdered coal, which is prepared in a mill house, which is erected at some little distance from the main boiler houses. Each pair of boilers has a steel chimney stack—see the accompanying engraving—having a height of 230ft.

The mill house to which we have previously referred, contains four sets of coal-pulverising plant, each comprising a steam-heated dryer with a designed capacity of 24 tons of coal per hour and two pendulum grinders of an equal combined capacity. There is a raw coal storage ground, shown to the right of our illustration. This ground has a capacity of 220,000 tons and it is served by two electrically operated transporters, each of which is designed to deal with 140 tons of coal per hour.

The main part of the power generated by the Klingenberg station is stepped up to 33,000 volts for transmission to the sub-stations and the Berlin underground railway system. The apparatus for the control of the high-tension circuits is housed in a special building, which is separated from the main turbine and boiler houses by a wide roadway. The dimensions of these different power station buildings are given in the accompanying table. The highest of them, the ten-storey administrative block, will be clearly picked out in the centre of our engraving, which also shows the wide expanse of the River Spree in front of the power station.

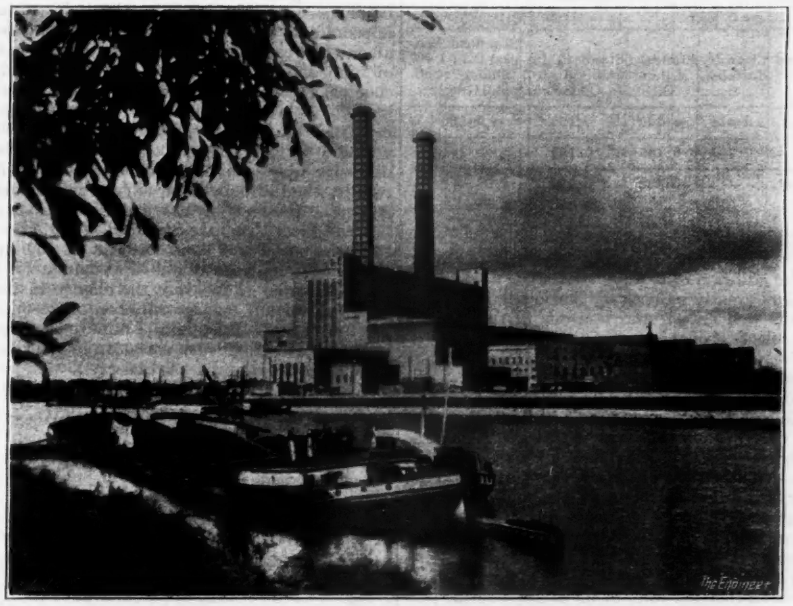
For a complete illustrated account of the main and house turbines and the generators and boiler feed pumps we may refer our readers to two articles which appeared in our issues of December 7th and 14th, 1928. Enough has been said to indicate the importance of this particular target. In conclusion, however, it is of interest to record that the power station is associated with a large horticultural business, with 10,000 square metres of glass houses, about 2½ acres in extent, which are near to the station and utilise its waste heat for the heating of the glass houses. During the season large crops of early tomatoes and cucumbers are produced, with an intermediate crop of beans and kohl-rabi.

### West Power Station

The other station referred to in the Air Ministry communications is the West power station on the lower Spree, which, it is recorded, has been the subject of two separate successful attacks. A view of this station is reproduced herewith. It was built at a later date than was Klingenberg, but, like that station, was designed for doubling at some later date. The design and construction of the station was entrusted to the Siemens-Schuckert Werke of Berlin, and work was begun in 1929. So quick was the progress made that by October, 1930, 130,000 kW of plant had been put to work, and in 1931 the complete installation of six turbo-generators, two house turbines, and eight boilers had been completed, providing a total output of 228,000 kW. It is of interest to recall that while the West station is of later and more modern design than the Klingenberg station already described, it is reserved primarily for peak-load services on account of the greater flexibility, experienced in practice, of the stoker-

fired boilers compared with the powdered fuel installation of boiler firing in use at Klingenberg.

The six main turbo-alternators taking steam from stoker-fired boilers at 455 lb. pressure and 797 deg. Fah. final temperature are of Siemens-Schuckert design, and each of them has a designed output of 34,000 kW; these, with the two 12,000 kW house turbines, provide a total output of 228,000 kW. The view of the station we reproduce shows clearly the distinct characteristic of the two large reinforced concrete and brick chimneys, which rise to a height of 360ft. from the ground.



BERLIN WEST POWER STATION

The eight boilers are of Borsig manufacture, each having a designed capacity of 150 tons of steam per hour. The boilers are fired by Taylor underfeed retort-type stokers, with an area of 710 square feet. The stokers are designed to utilise economically Westphalian, Silesian, and Ruhr coals. At the time they were installed the boilers were among the largest of their kind in Europe, and for the first time boiler tubes of 23ft. in length and 4in. in diameter were employed. In the design of these boilers provision is made for operating with preheated air at a temperature of 572 deg. Fah. by bringing into use special air heating surface. Alongside the power station there is, as indicated by our engraving, a large space for coal storage, which is served by coal transporters and a conveyor system delivering the coal to the boiler bunkers.

In the large attack on Berlin which was carried out by aircraft of the Royal Air Force on Monday night last, many of the targets mentioned in this article were heavily bombed.

# American Locomotive Design and Working

A NUMBER of features of detail in relation to the design, construction, and service or performance of locomotives were covered at the annual meeting of the Mechanical Division of the Association of American Railroads. Notes of some of these features are presented in the following summary of the report of the Committee on Locomotive Construction.

*Oil-Electric Locomotives.*—The report shows—as of December 31st, 1939—that of 749 oil-electric units in service, 250, or one-third, were put in operation during 1939 by 52 railways and operating companies, out of a total of 122 railways and companies owning such locomotives. In addition—as of January 1st, 1940—there were 57 locomotives on order for 16 companies. As to their power, of those in service, 447 were of 600 H.P. to 900 H.P. inclusive; 146 of 950 H.P. to 6000 H.P.; and 156 of less than 600 H.P. While in previous years the 600 H.P. figure has been most general, in 1939 there was a decided trend towards units of about 1000 H.P. Furthermore, of the 749 total, only 69 were for passenger train service, and four for freight train service, the other 676 being used for shunting and transfer work. Of the total maintenance cost of the engines, 18 per cent. was for the electrical equipment, and 59 per cent. for the oil-engine equipment. And of 71 engines of 600 H.P., the actual period of service was 20·2 hours per day, or 87·81 per cent. of a twenty-four hour continuous assignment. This indicates the high degree of availability of locomotives of this type.

*Design Details of Locomotives.*—One of the details covered by the report is a design for multiple-bearing crossheads of the underhung type, in which the connecting-rod attachment is below the slide bars. In this design the crosshead has two deep horizontal rectangular grooves on each side, to engage with ribs along the slide bars. The surfaces of these grooves, as well as the broad flat top of the crosshead, are finished all over and faced with tin. This design was suggested for "recommended practice," and will go to ballot vote for that purpose. A proposed tolerance for cotter keys of 0·005in. has not been received favourably by manufacturers, since it is closer than that of present commercial and Government standards. Such keys, being special for railway work, would not be kept in stock, and would have to be made in relatively small quantities at some 50 per cent. increase in cost over other keys made in lots of 100,000 or more. The Committee recommended that no change be made in existing standards, but that some form of expanding cotter should be used where a tighter fit is desired.

Revised designs were submitted for globe and angle valves on locomotive boilers carrying 300 lb. pressure. These included an increase in Brinell hardness from 175 to 225 for the seat ring and disc on all valves. Design of valves for superheated steam up to 400 lb. pressure and 750 deg. Fah. is still under study. Defects in cast steel disc driving wheel centres of the thin-wall type are tabulated, but these defective wheels are only from 0·48 to 7 per cent. of some 12,000 wheels in service, while a score of railways using these wheels report that they have no defects. Experience with heat-treated tyres on engine trailer wheels shows a record of 49,000 to 65,000 miles before failure, as compared with 19,000 to 27,700 miles for tyres not heat treated. Records of roller bearings on locomotives indicate their use on 1132 engine bogie axles or 4538 bearings, 450 on main driving wheel axles, 438 on other driving axles, 431 on all drivers, 529 on trailing bogie axles, and 969 on axles of tender bogies. In all, there is a total of 11,652 roller bearings on locomotives and tenders.

*Crank Pin Failures.*—An interesting study has been made of main crank pins that have failed or have been found defective on inspection. In a period of nine months, 75 railways operating 43,468 steam locomotives removed 1695 main crank pins from train engines, shunting and three-cylinder engines not being considered. Of those removed, 151 had failed (on 83 passenger engines and 68 freight engines), with an average mileage of 165,500 for the passenger and 169,600 for the freight engines. Failures were 41·34 per cent. in the wheel fit on passenger engines, and 54·10 per cent. on the freight engines; flush with face of hub, 32 and 18·03 per cent. respectively; at fillet next to hub, 18·66 and 18·03 per cent.; at journal of coupling-rod or side rod, 4 and 6·56 per cent.; at excentric fit and main rod journal, 4 and 3·28 per cent.

In a majority of cases the cause of failure was reported as "unknown," but "poor machining" was reported as the cause of 60 per cent. of the failures at fillet between main and side rod, main rod journal and excentric fit. Most of the failures were on freight engines of the 4–8–4 and 2–10–2 types, and passenger engines of the 4–6–2 type. Other causes for removal of crank pins were limit of wear and limit of mileage. While the regulations of the Association of American Railroads limit maximum fibre stress to 16,000 lb. per square inch, it appears that this limit was exceeded in 42 per cent. of the crank pins that failed.

The general conclusion of the report is that main crank pin failures are relatively more frequent, both in freight and passenger service on engines exerting high horse power at high sustained speeds. Thus the records indicate that for any driving wheel arrangement, as the number of trailing wheels increases, as necessitated by increased fire-box and boiler capacity, the ratio of failed and cracked pins to the number of engines in service increases also. Since the fibre stress should be kept below 15,000 lb. per square inch, locomotives designed for high power at sustained high speed should have the total piston thrust divided over two driving units.

Such design does not help the situation for locomotives now in service. However, this situation is not critical, since on an annual basis the number of crank pins that fail in service is only 0·2 per cent. of the number in service, and the yearly cost of replacing main crank pins that fail or are found cracked amounts to approximately £6000. On the other hand, failure on a locomotive at high speed will cause damage out of all proportion to the actual cost of replacing the pin. Since poor machining is indicated as the cause of 23·54 per cent. of all failures, considerable improvement can be attained through careful attention to the machining.

Next to this step is the setting up of mileage limits, according to type of engine and conditions of service. This must be done by each individual road. To increase materially the life of main crank pins, it is necessary to reduce the stress considerably or to find some means of increasing the life under present stresses involved. Reduction of stress is impracticable on existing engines and also on many new engines due to limitations in design imposed by axle diameter and length of stroke, which make it impossible to reduce the stress below 15,000 lb. per square inch. Two possible methods of increasing the life of crank pins under higher stresses are suggested in the report:—First, cold rolling the wheel fit of the pin, and, secondly, flame hardening this wheel fit. Both methods are definitely experimental, but the report recommends that experimental work be conducted along these lines.

*Locomotive Boiler Developments.*—On the subject of boiler supports between the fire-box and smoke-box, tests indicate that a waist-sheet or bearing at the guide yoke does not contribute much to vertical resistance. A waist-sheet in front of the rear drivers offers more resistance, since the effect of a reaction is to level out the bending moment curve. As it is not advisable to eliminate all connections between boiler and frame from fire-box to smoke-box, the report recommends a bearing between the cylinders and front fire-box bearing, preferably between the main and intermediate driving axles. This would offer maximum support to vertical deformations and minimise the stresses in the region immediately in rear of the cylinders. While such a bearing must have sufficient rigidity to withstand vertical impacts without yielding, it must provide for longitudinal expansion of the boiler. This requirement may be met by a sliding shoe bearing which would offer a large bolting flange to cradle the boiler, and give a low unit pressure on the sliding surface, thus ensuring positive resistance at all times. Some railways are now using supports of this general type, but located midway between the cylinders and front fire-box support.

A fusion-welded boiler has been in service on a locomotive of the Delaware and Hudson Railroad for two years, and on its second semi-annual inspection in November, 1939, it was washed, inspected, and subjected to a 350 lb. hydrostatic test. The jacket and lagging were removed for inspection of the welded seams, but all welding was found in good condition, and there was no trace of simmer or weeping. At that time the engine had a running record of 134,000 miles.

Although there are numerous types of locomotive boilers and fire-boxes in use, the great majority of boilers in service on American railways are of the conventional type. For this reason the report points out that it is desirable to determine the best solution of some of the problems involved in the design and maintenance of large boilers of this type. The principal trend has been towards increase in capacity, efficiency, and reliability, together with reduction in cost of maintenance. Capacity is controlled or limited largely by diameter, primarily owing to its control of gas area of the flues, which in turn is confined within close limits if other desirable proportions are not encroached upon. Such limiting proportions include distance between crown sheet and roof, between combustion chamber and shell at bottom and sides, between flues and fire-box side and crown, between flues to provide adequate circulation for maximum efficiency, as well as to prevent cracking of tube sheets between the tubes. Another important feature is the width of water space at foundation ring or mud ring, and the rate of increase of this width upward to the crown sheet.

Notes of a test made on the Denver and Rio Grande Railroad to determine the movements of the component parts of the back end of a boiler under hydrostatic pressure, close the report. The boiler was that of an engine of the 4–6–6–4 class, with fire-box 182in. by 104¼in. inside measurement, the length from back flue sheet to fire-box door sheet being 28ft. 2in. The fire-box had two siphons and a third was in the combustion chamber. Measurements under the tests were made at 206 points, and the pressures ranged from 100 lb. to 319 lb. per square inch. The water was at 100 deg. Fah., except that at 255 lb. pressure the temperature was 210 deg. It developed that the downward movement is smaller with the hotter water, while the lateral spread is greater.

In general, the tests showed that the top of the fire-box sags down and the sides spread out under pressure. The maximum downward movement was $\frac{7}{16}$in. for the roof sheet and $\frac{31}{64}$in. for the crown sheet. The maximum spread, taking both sides together, was $\frac{43}{64}$in. for the roof sheet and $\frac{35}{64}$in. for the crown sheet. For the siphons, the maximum downward movement was $\frac{1}{4}$in. Maximum spread was $\frac{3}{32}$in. at the mud ring or foundation ring, and $\frac{11}{16}$in. between the siphons. The maximum longitudinal movement, with water at 210 deg., was $\frac{19}{64}$in. These movements indicate that the back end of a boiler is continually moving up and down in the vertical direction, and in and out in the lateral direction, whenever there are changes in pressures and temperatures. Therefore, the back end must be of such substantial construction as to keep these movements within a practicable minimum. Thickness of roof sheet must also be developed to meet the deflection requirements as well as the strength requirements.

# Wear Phenomena in Lubricated Metal Surfaces*

By A. S. T. THOMSON, Ph.D., A.R.T.C., A.M.I.Mech.E., and R. LOGAN, A.R.T.C.

AN investigation into the wear problems associated with lubricated metal surfaces has recently been instituted in the Mechanical Engineering Department of the College, and the following article gives an account of some of the interesting features that have emerged during the preliminary tests.

The object of these tests was to investigate the effect of variation of load and lubricant on the wear rate of a specified metal rubbing combination. Brass on steel was chosen, as it was considered a reasonably practical bearing combination, and in addition the brass was expected to give a measurable amount of wear in a comparatively short time.

*Lubricants Used.*—Comparative tests were carried out with three lubricants: (*a*) a standard mineral oil; (*b*) the standard mineral oil + 0·5 per cent. oleic acid; and (*c*) the standard mineral oil + 1 per cent. "Oildag," a colloidal graphite preparation.

### OILINESS DETERMINATIONS

In view of the fact that wear will occur only when the fluid oil film has become so thin that high point contact occurs, it was thought advisable to obtain a measure of the "oiliness" of the three lubricants to be used and therefore tests were carried out on the Deeley static friction machine. The coefficients of static friction were determined for various surface combinations and the average results are given in Table I.

TABLE I

| Surface Combination. | Lubricant. | | | |
|---|---|---|---|---|
| Ni. Cr. Steel on | Clean dry Surfaces. | Standard Mineral Oil. | Standard Mineral Oil + 0·5 % Oleic Acid. | Standard Mineral Oil + 1·0% "Oildag" (Colloidal Graphite) |
| Cast Iron. | 0·414 | 0·200 | 0·122 | 0·206 |
| Brass. | 0·305 | 0·185 | 0·153 | 0·184 |
| White Metal. | — | 0·382 | 0·290 | — |

*Discussion of Results.*—From Table I the following points are evident:—

1. The addition of 0·5 per cent. oleic acid to the mineral oil greatly reduces the static friction. This feature is well known and was one of the reasons for the selection of this particular lubricant.
2. The addition of colloidal graphite did not appreciably effect the static friction.
3. For any one oil different coefficients of friction are obtained for different metals, and, further, the degree of difference changes with each lubricant. These effects are explained simply by the differing degrees of adsorption obtained, or, in other words, the varying adhesion forces in the metal and the varying cohesive power or surface tension of the oil.

### WEAR EXPERIMENTS

*Testing Equipment.*—The testing machine used for the wear investigation was, in its original form, presented to the Mechanical Engineering Department by

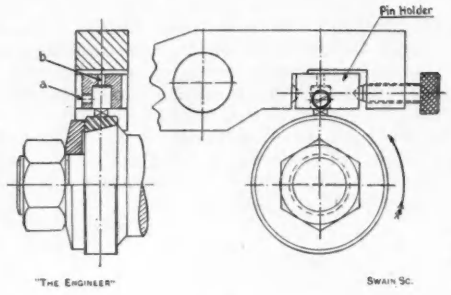



FIG. 1

the Macmillan Petroleum Corporation, U.S.A. It consisted basically of a ball-bearing spindle having a conical seat, with locking nut, for carrying the outer race or cup of a standard Timken bearing. A lever system enabled a Timken roller to be pressed against the rotating cup, which dipped into a small oil bath. As received, the machine proved quite unsuitable for accurate work. It has therefore been redesigned and is now as shown in Fig. 1 and Fig. 2. It will be seen that the small oil bath, which gave no facilities for temperature control, has been replaced by one of large capacity fitted with a water jacket and tubular electric heater. By means of a control panel no difficulty was experienced in maintaining the bath temperature at any desired value.

The machine has been converted to the "brake shoe" type by replacing the original small Timken roller wear element by a hard steel block drilled to hold the brass wearing pins (Fig. 2). The pins were cut from round brass stock and carefully squared at one end. They were locked in position by the small set screw *a* and the hole *b* served as a means of access for removal.

Other additions included a wear indicating dial, a revolution counter, a torsionmeter and a motor control panel.

*Wear Measurements.*—In addition to the time-wear record obtained by the dial gauge, actual wear measurements were made before and after each test. The wear of the pin was expressed as cubic inches of metal removed per minute. It might be mentioned here that throughout the tests no measurable wear was noticed on the steel Timken cups.

*Running-in Procedure.*—The original surface finish of the steel Timken cups was suspected of lacking uniformity. Before testing, therefore, the surfaces were brought to a uniform condition by a standard treatment with fine emery cloth and subsequent thorough cleaning.

The brass pins were run in on the standardised Timken cup surface at a load of 200 lb. per square inch, and an oil bath temperature of 140 deg. Fah., the cup speed being 650 r.p.m. After about five minutes at these conditions the pin was found to have formed a smooth concave mating surface and was ready for testing.

*Bearing Pressure.*—It was found that after very little running the edges of the brass pin "burred over" or "mushroomed." This naturally increased the area and reduced the bearing pressure. As the "burrs" could not support the full load at the tips it was decided to use the mean of the overall and original areas when calculating the bearing pressure.

*Effect of Metal Detritus.*—In the absence of a pump circulating and oil straining system the brass detritus accumulated in the bath and could be easily seen in the oil as it swirled about the rotating cup. To investigate the effect of this variable typical wear readings were taken with a particular pin and cup before and after changing to fresh oil. Almost identical wear readings were obtained in the two cases. This appeared to suggest that the brass detritus did not affect the wear, but, as brass was observed in the clean oil immediately after the test began, a second possible conclusion was that a small amount was just as harmful as a large quantity. In any case, the test indicated that the accumulation of brass was not a variable factor. In support of this conclusion no difficulty was experienced in later tests in repeating results, even although the oil was not changed until it became quite heavily charged with brass particles.

*Wear Tests Using the Standard Mineral Oil.*—In all tests the speed was kept constant at 650 r.p.m. and the bath temperature was approximately 140 deg. Fah. In order to measure the change in the rate of wear with load, a large number of 2½-minute unit tests were run. By taking ½-minute readings on the indicator dial gauge any variation in the rate of wear during the 2½ minutes was observed.

With a new cup, fresh oil and a new brass pin, just

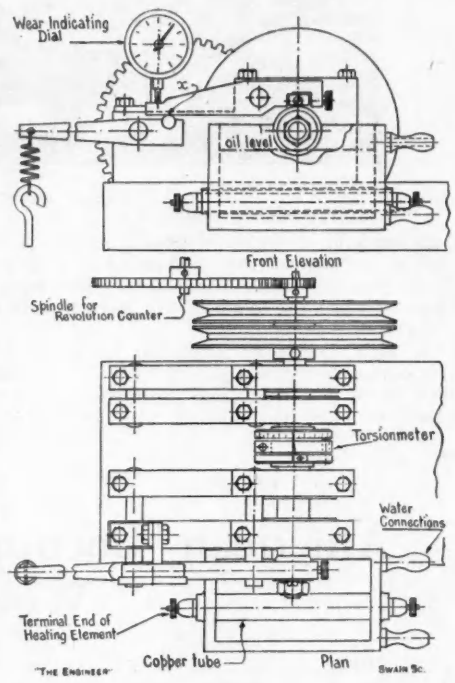



FIG. 2

run in, a series of tests was begun, and repeat values were taken before changing to a higher load.

Up to pressures of about 1650 lb. per square inch the rate of wear was found to be constant for any particular pressure and the overall rate increased as the load was increased. Four of five brass pins were worn away in investigating this range. Using a new pin, just run in, the load was now increased to 2400 lb. per square inch. On observing the wear indicator dial it appeared that the wear rate had dropped to a very low value. That this was actually the case was verified by micrometer measurement and several repeat tests. In case this low rate of wear was a feature of the high load only, the load was reduced to 1300 lb. per square inch, and the same small wear readings were recorded.

Tests were now carried out at still higher bearing pressures, the object being to discover the maximum load that this new condition would sustain. This was found to be about 3000 lb. per square inch, and if the load intensity were increased beyond this point the condition of rapidly increasing wear with load returned.

As already noted, all tests were started and controlled at 140 deg. Fah. With the higher intensities, however, it was found that the temperature of the rim of oil thrown up by the cup increased quite rapidly. On examining the indicator readings from such a test the wear rate was found not to be constant, but to be increasing with the temperature.

As a further illustration of the effect of temperature on conditions above the upper critical load of 3000 lb. per square inch the heater was switched off and a test run at 100 deg. Fah. with a bearing pressure of 4000 lb. per square inch. A very low rate of wear was obtained.

In all, about ninety unit tests were made using numerous brass pins and several steel Timken cups. No difficulty was experienced in obtaining check readings with fresh specimens, characteristic values

* Reprinted from the *Journal* of the Royal Technical College, Glasgow.

being recorded in all cases. The results of the series are shown in Fig. 3.

*Summary of Results from Standard Mineral Oil Tests.*—The main features of the results shown in Fig. 3 may be summarised as follows :—

1. From zero load up to 1650 lb. per square inch the rate of wear increased at a constant rate—line OA, Fig. 3.
2. At pressures above 1650 lb. per square inch and below 3000 lb. per square inch the brass surface underwent a change, and very low wear rates were obtained—line B C. For the purpose of reference this region has been termed the "hardened" region.
3. The "hardened" condition was accompanied by the appearance of smooth polished bands on the pin surface. This smooth area varied from one or two narrow bands to almost the entire pin bearing surface.
4. Once a pin had been hardened it gave low wear at pressures less than 1650 lb. per square inch —line O B.
5. A pin could not be made to give a value on line O B without first having been "hardened" by a pressure between that of B and C.
6. All wear values obtained that were not on the above-mentioned lines were shown by the indicator dial to be changing rates and, on analysis, were found to be tending towards a value on one or other of the lines. Repeat tests confirmed this feature.

*Wear Tests Using the Standard Mineral Oil + 0·5 Per Cent. Oleic Acid.*—The conditions for this series of experiments were the same as for those just described, the only difference being the change of lubricant. About sixty tests were carried out and the results are shown in Fig. 4.

*Summary of Results from Oleic Acid "Doped" Oil Tests.*—From Fig. 4 it will be seen that the main features of the results obtained with the pure mineral oil are repeated with the following differences :—

1. The lower critical pressure was much more definite and occurred at 1300 lb. per square inch ; that is, at B, Fig. 4.
2. The upper critical pressure was not so well defined, but appeared to be in the region of 5000 lb. per square inch, as compared with 3000 lb. per square inch for the standard mineral oil. In addition, beyond this point the rate of wear was very much lower than that obtained in the previous case.
3. Line O B was not definite, as most of the wear rates measured were not constant but tended towards O A.
4. The gradient of O A was similar to that given by the pure mineral oil.

*Wear Tests Using the Standard Mineral Oil + 1 Per Cent. "Oildag" (Colloidal Graphite).*—Again all the conditions were the same as for the previous tests, and about sixty tests were run using the graphited oil. The results are shown in Fig. 5.

*Summary of Results from Graphited Oil Tests.*—Again the main features of the previous experiments are shown. In this case there is a marked similarity to the results obtained with the pure mineral oil. The characteristics of this series are :—

1. The lower critical pressure is about 1200 lb. per square inch ; that is, lower than that for the pure mineral oil.
2. The upper critical equals that for the mineral oil at 3000 lb. per square inch.
3. Results obtained at pressures beyond 3000 lb. per square inch are shown grouped along line C E. The indicator dial showed that in these cases the wear had taken place during the last minute or so of the test. When the measured values were proportioned up to 2½ minutes, line C D was obtained. Thus, it would appear that the colloidal graphite had prevented wear from starting for about one minute. After this initial period the wear gradient obtained was lower than that for the pure mineral oil, but still very much higher than that for the mineral oil plus oleic acid.

### Discussion of Results

The most interesting feature emerging from the tests is undoubtedly the occurrence of the low wear section B C. To investigate whether or not work hardening was responsible for this feature numerous tests were carried out on both the Rockwell and Herbert pendulum hardness testing machines, but no appreciable difference in the hardness of the brass could be detected. The possibility, however, of a thin oxide skin, too thin to affect the indentation hardness, must not be overlooked.

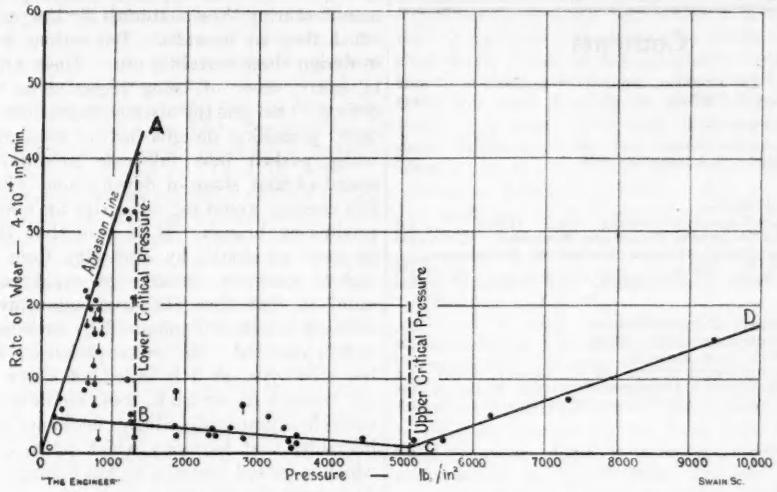
Attention was now directed to the change in appearance of the brass pin surface. The smooth bands associated with the region B C suggested that the small amount of wear in this region might be due to the interposition of a thin oil film which would minimise high point contacts, the incidence of the film being due to the extreme smoothness of the surfaces. On examining the results in the light of this hypothesis several points of agreement were observed.

In the first place, the conditions of line O A were assumed to be those of pure abrasion, the asperities of the cup getting through the asperities of the pin like so many cutting tools. The appearance of the surfaces under the microscope supported this contention.

As the load was increased the surface temperatures would build up until at several highly localised points the melting point of the brass would be reached momentarily. When the brass melted it would be "wiped" by the rotating cup. This wiping action would not only smooth the brass, but also the cup, as tiny particles of brass would fuse on to the cup surface and level up the surface irregularities. Mass melting of the brass surface would be prevented by the cooling action of the lubricant. The smooth surfaces thus formed would facilitate the formation of a partially viscous oil film and so minimise wear. The upper critical would then mark the film rupture pressure for the particular oil. This is in agreement with the results, as oils containing fatty acid additions have higher film strengths than pure mineral oils.

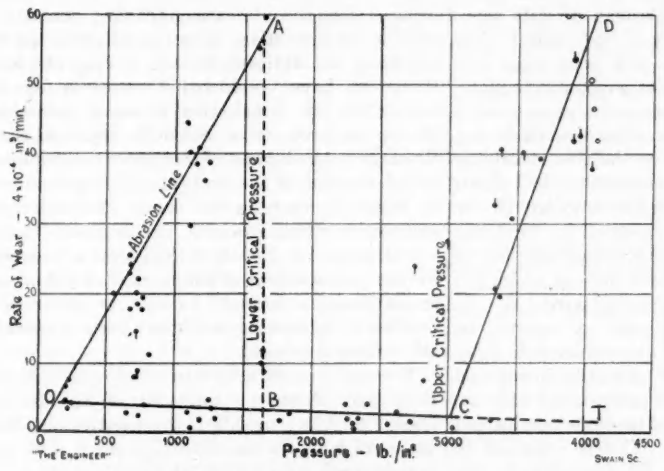
Further support is given to the oil film theory by the fact that when the oil bath temperature was lowered the upper critical pressure was increased.

As has been already stated, above the upper critical pressure a large quantity of heat was generated. Readings of the pin temperature indicated that the surface temperature must have been extremely high. It is suggested that in this region the softening or melting point was reached over almost the entire brass rubbing surface, whereas in region O A the mass of the surface would be comparatively cool. This elevated temperature with its attendant lowering of fatigue strength would result in a state of rapid wear.



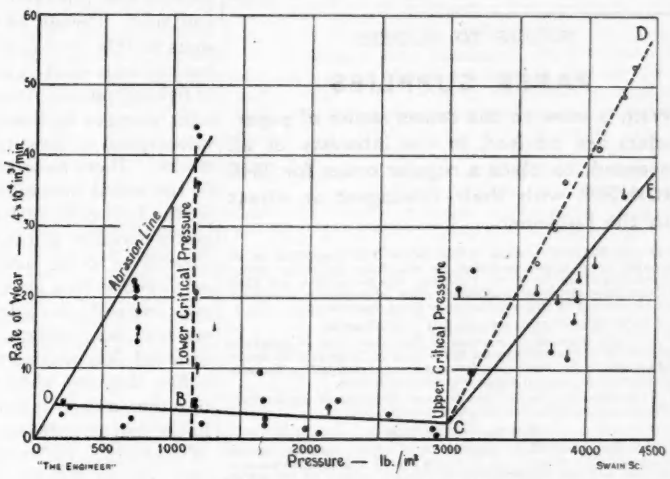

Pure Mineral Oil + 0·5 per cent. Oleic Acid Points obtained from 2½ min. tests

FIG. 4




Pure Mineral Oil. Points obtained from 2½ minute tests
T—Test point with temp. 100° F O—Proportioned

FIG. 3




Pure Mineral Oil + 1 per cent. Oildag Colloidal Graphite
Points obtained from 2½ min. tests O—Proportioned

FIG. 5

This work was carried out in the Civil and Mechanical Engineering Department, and the authors wish to express their thanks to Professor Wm. Kerr, Ph.D., M.I. Mech. E., for providing the facilities for carrying out the tests and for his helpful interest in the work.

## Development in Cutting Tools

We learn from Deloro Smelting and Refining Company, Ltd., of Shirley, Birmingham, that development work has now reached the stage where the company feels justified in offering a new Grade 80 Stellite for general consumption. In the main it has the same general characteristics as Grade 40, including ease of grinding, but the difference in its composition enables it to enter fields in which Stellite has previously not been used. It is stated that Grade 80 has met with success in the machining of the higher tensile steels, such as are used in the automobile industry.

The same general conditions must be maintained as in the case of Grade 40 Stellite, namely, fixtures and tool holders must be as rigid as possible, with the minimum of overhang. The more efficient a machine tool unit is, the better will be the result obtained. Grade 80 Stellite is not supplied as bar stock, but only in the form of finished tool bits, tipped tools, milling cutter blades and special formed tools, both rectangular and circular in shape. The latter is a recent development and in this particular direction, it is claimed, presents a marked advantage in that it is not economical to manufacture the circular formed tool from tungsten carbide. Results have, it is stated, proved that Grade 80 Stellite will give a 6 to 1 advantage in life per grind over high-speed steel.

Stellite Grade 80 is also used in the form of taper and parallel, hand and machine reamers when used on the lighter alloys of the duralumin group. In such cases the cutting portions of the reamer only are made from Stellite, and the teeth are ground straight into the Stellite. On account of its inherent hardness no heat treatment is required.

# The Engineer

*SEPTEMBER 27, 1940*

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## GERMAN AIRCRAFT DESIGN

IT is natural in these days that there should be speculation as to the quality of the aircraft under production or in reserve in Germany. Since quality includes considerations of design, materials and workmanship, the questions raised by such an inquiry are of wide scope. The great number of German aircraft shot down in this country has given the authorities ample opportunity to examine into all these factors, and to study in full detail the important range of aircraft instruments, armament and other accessories with which such aircraft are equipped. When the right time comes the public will no doubt be informed officially of the chief conclusions reached, but that may not be for a good while to come. In the meantime a purely unofficial discussion of the subject may not be out of place.

As regards the chief materials of aircraft construction and operation, aluminium, steel, magnesium and oil, the blockade of imports has had an important potential effect, though the invasion by the Germans of neighbour countries has procured for them large stores to supplement those they had already. Some of the rarer metals for alloying are, however, not to be found in Europe, but the quantities required are commonly small, and so long as the U.S.S.R. is willing to help Germany one cannot say that supplies, at a price, may not be forthcoming. Moreover, the Germans are ingenious chemists and the field of substitute materials is certain to be meticulously explored. We are so far unaware of any definite instance of a serious failure in the supply of essential materials, although the destruction of oil reserves (including the provision of lubricants especially) by the R.A.F. may well be causing anxiety to the German authorities. Nor can we point to any failure in the quality of workmanship employed in preparing or manufacturing these materials for the purposes for which they are intended. But serious deficiencies in design there certainly are. These are worthy, in many cases, of being regarded as very real defects. One gets the distinct impression of certain quite promising designs having been spoiled by being pushed into full-scale production much ahead of that stage of development which we in this country would regard as ripe for release to the production branch. It is true that this haste, imposed no doubt by authority from the very highest quarters, makes for rapid increase in numbers, but that the true aggregate fighting strength is actually enhanced by such means may well be doubted. Our own experience is that when the prototype, as it is called, of a new design is put through its air trials, some modification in the controls is practically always necessary in order to introduce that harmony which pilots expect and which is indeed essential to full fighting efficiency. The search for this fine balance of qualities almost always means repeated modification and further trial, for it is rare indeed for any single change to affect one quality only of the aeroplane. The aerodynamic controls are not independent of one another and when one is altered the others are affected and this often entails further adjustment and trial. Certain of the German aircraft show signs of this very important developmental work having been short-circuited, with consequent loss of fighting power. It is almost impossible to make later changes in design without a most serious interruption in the output from the manufacturing works. There have also been definite oversights in the initial operational requirements laid down by the Luftwaffe, such as the failure to provide for power-operated gun turrets, a detail by no means capable of being added without serious loss of performance to a given aircraft lay-out which did not originally include any such provision. In entirely new designs they can, of course, be included, but waiting for that means much delay before they are able to be generally introduced into the service. A doubtful policy is the wide use in German aircraft engines of fuel injection instead of employing carburetters. This is supposed to give greater freedom from ice formation in the intake, and it was at one time very favourably thought of in America; but the *pros* and *cons* seem to be fairly evenly balanced and engineers will watch with interest to see whether German designers persist with this feature. So far as instruments and accessories generally are concerned, enemy aircraft show abundant ingenuity, though it is remarkable how persistent have proved the basic designs introduced originally in the war of 1914–18; in detail there are many changes, but the essential principles of operation are as widely employed now as they were then. A quite novel feature is the fusing of bombs by means of small electric condensers, which are charged just before release; the anticipated advantage would seem to be the employment of tradesmen hitherto engaged in other than the normal German armament industry, but serious risk is incurred, one cannot but suspect, of a large proportion of blind bombs.

An authoritative estimate puts the present German output of aircraft at about fifty per day, which, when allowance is made for the yet larger figure for losses, by fighting and by accident, must represent a decided, and to us welcome, daily decrease in the numbers of aircraft available to the enemy for the purposes of the war. To lead in quality has always been our aim, but it now appears certain that to lead in quantity as well will be our achievement in the near future.

### The Oiliness of Lubricating Oils

IT is common knowledge that the lubricating value of a liquid is determined jointly by its viscosity and by another property to which the name "oiliness" has been widely given. This second property is of an elusive nature and cannot be defined in physical terms as can viscosity. The part which viscosity plays in lubricating metal surfaces moving in contact relatively to one another is well understood to be the secondary, but very essential one, of providing the means whereby the lubricant is maintained between the surfaces and prevented from being squeezed out under the applied load. Of itself viscosity cannot serve to reduce the natural friction between the surfaces, since it is that property of a fluid which imposes resistance to the relative sliding movement of adjacent layers of the fluid. The real friction-reducing property of a lubricant resides in its quality of "oiliness." The viscosity of an oil can be measured quite satisfactorily in either absolute or relative terms. There is, however, at present no precise definition of oiliness or a unit by which to measure it. This much, however, can be said: since the viscosity of a fluid is not manifested unless and until there is relative movement between its layers, it cannot enter into the factors determining the static coefficient of friction between two lubricated metal surfaces. It does not necessarily follow that that coefficient is determined solely by the oiliness of the lubricant, but there are grounds for believing that it is the main factor which fixes the value of the static coefficient when the conditions are such that the lubrication is of the "boundary" type; that is to say, when the thickness of the lubricating film is of molecular dimensions, the film being composed in the extreme case, not of oil, but of an oil-metal layer in contact with a similar layer. On the theory that the static coefficient of friction exhibited by lubricated surfaces when the lubrication is of the "boundary" type is an indication, if not a measure, of the oiliness of the lubricant, Messrs. A. Fogg and S. A. Hunwicks have conducted a research on the subject for the Lubrication Research Committee of the Department of Scientific and Industrial Research. An abstract of their report as published in the *Journal* of the Institute of Petroleum will be found elsewhere in this issue. The underlying supposition being granted, the research has, it would seem, resulted in establishing a technique for the measurement of the oiliness of a fluid and in addition has brought to light or confirmed a number of interesting subsidiary facts concerning lubrication in general.

The experimental apparatus employed by Messrs. Fogg and Hunwicks consisted of the familiar Deely machine, modified by substituting three $\frac{1}{2}$in. steel balls for the three flat pegs. The balls were pressed with variable loading against a steel disc immersed in a bath of the lubricant under test. The carriage to which the balls were fixed was fitted with a torque measuring device, and when the disc was slowly rotated the torque registered at the instant at which the balls and carriage slipped relatively to the disc was noted. All the tests were carried out with a load on the carriage equivalent to a mean pressure of 30·3 tons per square inch between the balls and the disc, a preliminary investigation having shown that the coefficient of friction deduced from the torque at slip varied inappreciably with the load at any given temperature of the oil bath. The problem of cleaning the contacting surfaces was one of prime importance. Various processes for obtaining chemically clean surfaces have been tried, such as the use of solvents—alcohol, trichlorethylene or a mixture of alcohol, ether and ammoria—or Hardy's process involving the use of chromium sesquioxide. Messrs. Fogg and Hunwicks resorted to the seemingly drastic but very certain method of removing the contaminated surfaces completely by abrasion with very fine emery and of performing their experiments immediately after such removal in order to avoid re-contamination from atmospheric sources. It was found as a result of several hundred experiments that the surfaces cleaned in this manner gave a coefficient of friction which always lay between 0·56 and 0·60. It may therefore be taken that $\mu=0{\cdot}58$ represents the static coefficient of friction for steel on steel in the entire absence of lubricant. The "oiliness" of any lubricant is therefore to be judged by the degree by which the static coefficient of friction given by it falls below this extreme limit. A striking result soon became apparent in connection with the efficacy of the established solvent cleaning processes. After the contaminated surfaces had been

cleaned with trichlorethylene the value of $\mu$ was found to be 0·33 and not 0·58, as it should have been if the surfaces had really been cleaned by the process. When trichlorethylene was used in the bath as a lubricant it gave the same value of $\mu$, namely, 0·33. Like results were obtained with the other solvent cleansers. In other words, these "cleansers" remove the original contamination, but remain adsorbed on the surfaces and act precisely as they would do if they were used as lubricants. The difficulty of obtaining a "clean" surface would seem to be hardly greater than the difficulty of maintaining in the "clean" state a surface after it has been cleaned. For example, the surfaces after being cleaned by abrasion to $\mu$=0·58 were lightly rubbed with the fingers in a normal state of cleanliness after washing. Immediately the coefficient of friction fell to 0·10, a value of $\mu$ of the same order as that given by animal and vegetable lubricating oils.

In their published report Messrs. Fogg and Hunwicks give the results which they obtained with a large number of oils and a few common liquids. As would be expected, pure oleic acid exhibited the maximum oiliness, namely, $\mu$=0·08, at all temperatures. The gamut of oiliness may therefore be said to cover the range from $\mu$=0·08 to $\mu$=0·58. A selection of the many results given in the report is reproduced in our abstract of it, but the position as a whole may best be gathered from the diagrammatic "scale of oiliness" which we reproduce from the original paper. The fatty oils, it will be noted, possess the greatest degrees of oiliness, while the extreme pressure oils cover partially the same range. Higher up come the mineral oils. It will be observed that graphited mineral oil is the best of this group and that a synthetic mineral oil produced by the Fischer process at the Fuel Research Station occupies quite a good position. Although glycerine is not usually regarded as a lubricant, it will be seen that from the point of view of oiliness it is not much worse than paraffin. The effect of compounding oils was investigated by studying two mixtures, one consisting of a mineral oil with various proportions of rape oil and the other of paraffin with various proportions of oleic acid. The results confirmed practical experience, namely, that the principal improvement achieved by compounding is realised by the first small percentage additions, although in the case of mineral oil compounded with rape oil a higher percentage than the usual 5 per cent. of rape oil might be used with advantage. As has already been remarked, all the results relate to the oiliness of oils as manifested between steel and steel. That combination of metals is not one of the most important in practical engineering, and it must not be assumed that exactly the same results would be obtained with other combinations of metals such as steel and brass or steel and white metal. Indeed, when we remember the important part played in boundary lubrication —or supposed to be played—by the union of the oil molecules with the metal molecules of the contacting surfaces, it would be somewhat surprising if the oiliness characteristics as measured by Messrs. Fogg and Hunwicks' method were the same for the same oil, but different metals. It is therefore interesting to learn that it is intended to extend the research to other combinations of metals besides steel and steel. Whether the static coefficient of friction under boundary lubrication conditions is a true physical measure of the oiliness of a lubricant will doubtlessly be debated. At present it is an assumption with but little theoretical justification. Nevertheless, the results of this interesting research seem to support the assumption fairly strongly in so far as they place the various lubricating oils in substantially the same order of oiliness as that which practical experience has in general assigned to them.

## Obituary

### CHRISTOPHER SAMUEL DAVY

WE regret to have to record the death of Mr. Christopher Samuel Davy, a director of Babcock and Wilcox, Ltd. Mr. Davy was born in London on March 2nd, 1870. He received his primary education at a private school and his technical education at Birkbeck Institute (now Birkbeck College). His first apprenticeship was with Samuel Worssam and Co., saw mill engineers, of Chelsea, with whom he stayed from 1885 to 1887. In the latter year his indentures were transferred to Sir W. G. Armstrong, Mitchell and Co., Ltd., of Elswick Works, Newcastle-on-Tyne. He found time there to attend the Elswick Institute. He completed his articles in 1890, and for some years thereafter seems to have been restlessly seeking for work that would be satisfactory to him. He joined the firm of Tangyes, Ltd., for two years, taking the opportunity at the same time to study at Birmingham University. Then in 1892 he became chief draughtsman in the works of Grenfell and Eccles, Ltd., a firm engaged in the manufacture of machine guns, machine tools, and special machinery generally. Two years later, however, he came to London, and for another two years worked in his private capacity as a draughtsman and consulting engineer. It was on November 1st, 1897, that he joined Babcock and Wilcox, Ltd., in London, in the relatively lowly capacity of a draughtsman. Within three years he became chief of the technical department, and he retained that position until 1919, when he was made London office manager. Eight years later he was appointed assistant general manager, and later chief engineer. From November, 1933, until December, 1935, he combined his duties as chief engineer with his work as a member of the board. Thereafter he retired from the former position, but remained a director, and took an active part in the deliberations of the board until attacked by the short illness that preceded his death.

Mr. Davy, during his forty-two years' association with Babcock and Wilcox, Ltd., saw the water-tube boiler develop from small units, evaporating a few thousand pounds of water per hour to units evaporating 550,000 lb. of water per hour, while the pressures increased from the neighbourhood of 100 lb. per square inch to, in some instances, as much as 2000 lb. per square inch, and temperatures from saturation point to over 950 deg. Fah. As chief of the technical department of the company and later as chief engineer, he exercised a commanding influence on boiler development, and was recognised as one of the leading engineers in steam-raising plant. In addition to dealing with the major boiler developments, including economiser and air heater work, he developed and improved the chain grate type of stoker, and his name is associated with many patents in connection with every phase of boiler plant. For many years he also took a leading part in the commercial activities of Babcock and Wilcox, Ltd., and travelled extensively abroad in the company's interests.

To those who did not know him well he sometimes appeared to be a man of stern and unbending character, but by his many friends—and they were numerous and scattered all over the world—he was respected and admired as a man of upright character, straightforward dealing, and possessed of qualities which endear a man to his fellow-men.

## Literature

*Steel Manufacture Simply Explained.* By ERIC N. SIMONS and EDWIN GREGORY. London: Sir Isaac Pitman and Sons, Ltd. 1940. Price 6s.

IT may be said that the average mechanical engineer has no more than a distant acquaintance with the materials he employs. That is particularly true of steel. About cast iron and the non-ferrous metals he learns something during his experiences in works' foundries. But his knowledge of steel begins with the finished material either as bars or castings. He is familiar with the usual names, such as Bessemer, Open-hearth, Crucible, and so on, but knows very little about the operations through which the ore must pass before it is converted into material suitable for his use. There is no practical reason why he should know more; why he should burden his brain, overloaded already perhaps, with information of which he can never make use. On the other hand, it may be said justly that the broader his knowledge —if he uses it with discretion—the better man will he be. Furthermore, we have, fortunately, with us many and many engineers of all ages of of an inquisitive turn of mind who like to "know" for the sake of "knowing."

Now, the science of steel and steel making is a very expert business with an extensive and alarming library. No one not specially devoted to the subject could be expected to be well acquainted with it. The book under our hands is therefore particularly welcome. Of its kind it is a masterpiece, for the joint authors have succeeded, in the space of 160 pages, in presenting an outline of the whole process of steel making. "Outline" is not quite the right word; not quite fair. It suggests superficiality, and whilst it is quite true that the authors have left out a thousand details they have given us the substance rather than the mere shadow of the art. And they have done their job with remarkable skill. None of the chapters is long, but in each of them they have dealt faithfully with the matter in hand and with a clearness of exposition that makes the reading a positive pleasure. Any attempt to over-elaborate or to follow up any of the knotty problems—like the relative merits of Bessemer and open-hearth steels—has been restrained so that the reader is left with a clear picture, unburdened with detail.

It may be useful to add in conclusion to this short review of a book which we heartily commend to engineers that one of the authors, Mr. Eric Simons, is publicity manager to Edgar Allen and Co., Ltd., and the other, Mr. Edwin Gregory, is chief metallurgist to the Park Gate Iron and Steel Company, Ltd. Is it fanciful to see in this combination a resemblance between barrister and solicitor, both learned in the law, one knowing how to present effectively the evidence collected by the other?

## Sixty Years Ago

### THE REV. ARTHUR RIGG

ENGINEERING and the kindred arts owe more than one debt to the clerical profession. Among the less well-known of its reverend beneficiaries is Arthur Rigg, Master of Arts, who died in London on September 2nd, 1880. By a devious process, his life's work was set to run on lines which were to lead to the establishment of science as a recognised ingredient in the education of engineers. He was born at Carlisle in March, 1812, and after a private education he entered Christ's College, Cambridge, in 1832, graduating as twenty-seventh Wrangler in 1835. After being ordained, he held the position of senior mathematical and philosophical master at the Royal Institution, Liverpool, for four years. At that period the leading men in the diocese of Chester were anxious to increase the numbers and improve the efficiency of the national schoolmasters. It was accordingly resolved to establish a training college at Chester, and to appoint Mr. Rigg as its principal. After carrying on for a time in temporary premises, a permanent college was built and formally opened by Mr. Gladstone in 1842. Accommodation was provided for fifty students to be trained as schoolmasters, with 110 daily pupils as their practising school, together with seventy scholars to whom a commercial or practical education was to be given instead of the then standard classical education. From the first it was considered advisable to combine a sound intellectual education with instruction in various manual trades. To that end the students were set to work on the building of their own college chapel. They dug the foundations, quarried and carved the stone for the structure, and set up carpentering and blacksmithing shops. From this beginning training in handicraft skill became a regular feature of the college curriculum. Workshops were established and equipped with tools and lathes, and gradually the college developed in large part into a scientific and engineering school. Financial prosperity attended the venture, and by 1853 many applications for admission had to be refused. By 1860 the school was certified as possessing all the requirements for the preparation of candidates for the Engineering Department of Public Works in India. A new generation of members had, however, entered the Chester Diocesan Board of Education. They failed to take the warm interest in Mr. Rigg's educational plans which their forerunners had done, and in 1869, wearied by the want of sympathy with his technical work, he resigned his position as principal of the college. With his resignation, the technical school at Chester practically ceased to exist. He then settled in London in order to be in touch with the scientific world which he loved so well. In the Society of Arts he found a congenial atmosphere. Before it he delivered a series of lectures on "Mechanism" in 1872, and on "The Energies of the Imponderables" in 1873, and a series of Cantor Lectures in 1875 on "Tools and Contrivances Used in Handicrafts." He was also a member of the Institution of Mechanical Engineers and of the Royal Institution. Although so much of his life was devoted to science and engineering, he did not abandon or forget his clerical calling. His sermons were distinguished by their practical bent, and were illustrated with vigour and freshness by examples drawn from everyday life, such as Smeaton's use of an oak tree as his model for the Eddystone Lighthouse.

# The United States Liner "America"

No. V

(*Continued from page 190, September 20th*)

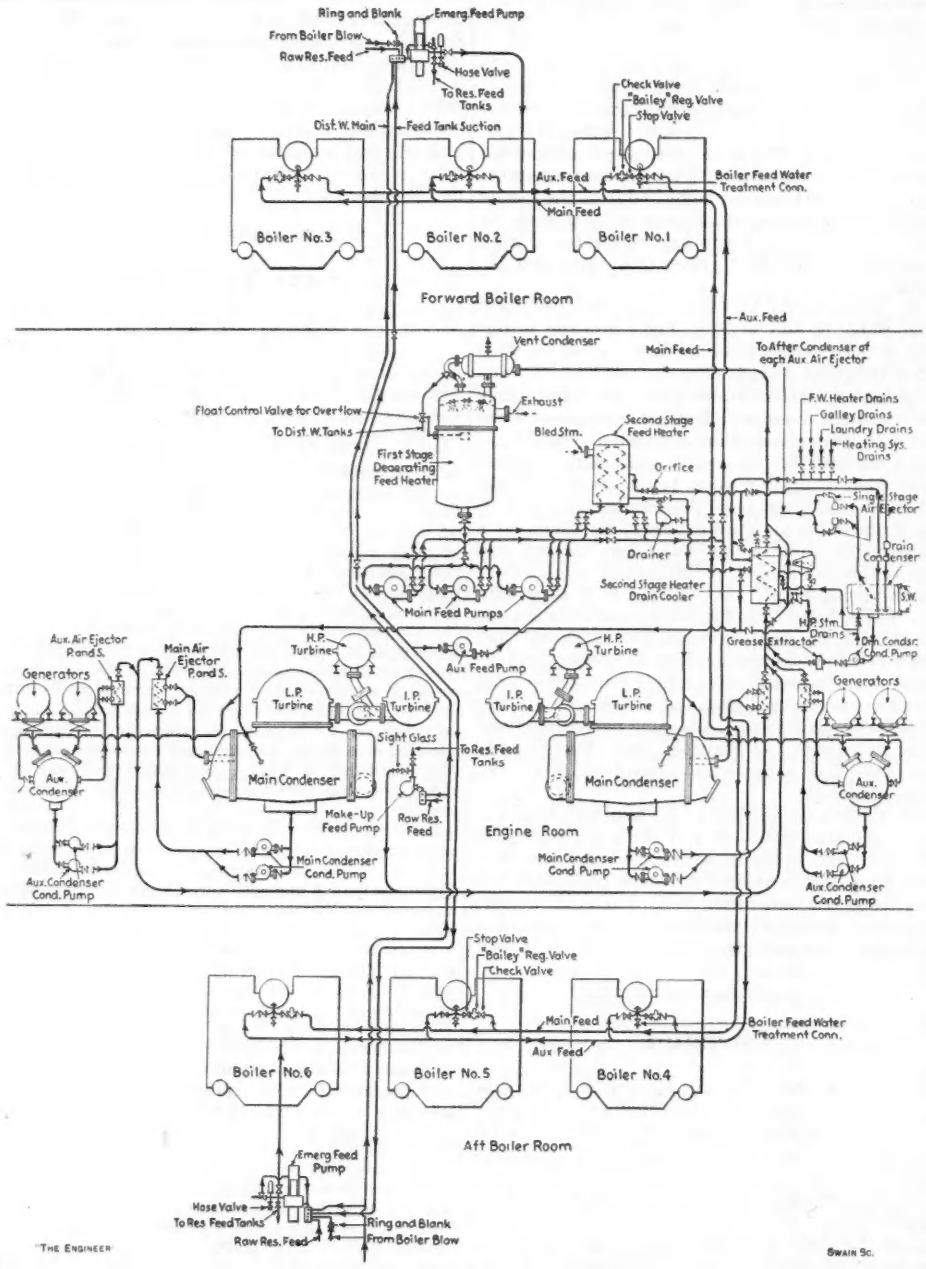
IN this article we conclude our description of the United States liner "America," which is now completing her maiden voyage from New York to and from the West Indies. Having described the main propelling machinery, we now deal with the feed-heating and pumping systems and other auxiliary machinery.

### Feed and Condensate System

The feed and condensate system is of the closed deaerating type, arranged for stage feed heating. The general arrangement of the system will be seen from the accompanying drawing. The condensate from each main and auxiliary condenser is discharged by its condensate pump to the deaerating heater *via* its own inter and after-air ejector condenser, the drain cooler, and the deaerating heater vent condenser, and is maintained continuously above atmospheric pressure in order to avoid the possibility of air leaks. The feed pumps are connected on their suction sides to the deaerating heater and discharge to the boilers *via* the high-pressure feed heater. The drain cooler is of the straight-tube vertical pattern, and the working pressure in the shell is approximately atmospheric. It normally receives the drains from the second-stage feed heater, evaporators, contaminated steam generators, and the ship's services, other than those taking steam from the contaminated system. The cooled drains from the cooler are led to the main or auxiliary condensers.

The first-stage or deaerating heater is of the direct-contact spray type, with a vent condenser, and it has a storage compartment of about 4600 gallons capacity.

It is designed to heat the total feed to about 230 deg. Fah., and to deaerate the condensate to a maximum oxygen content of 0·01 cubic centimetres per litre. The heater is supplied with auxiliary exhaust, low-pressure bled steam from the main turbines and generators, vapour from the fresh-water evaporators, and with reduced-pressure live steam if any deficiency should occur while manœuvring. The heater is placed about 35ft. above the feed pumps so as to ensure against evaporation at the feed pump suction. The second-stage or high-pressure feed heater is of the straight-tube, four-pass type, and it is designed to heat the total feed to 300 deg. Fah. when supplied with high-pressure bled steam from the main turbines at a pressure of 70 lb. gauge. The drains from the heater are led to the drain cooler.




**Arrangement of Feed and Condensate System**

### Lubricating and Oil Fuel Systems

Each of the main turbines and reduction gears is served by an independent lubricating oil system of the gravity type, which comprises two pumps, two coolers, and a 1500-gallon gravity tank. One pump and one cooler are provided as spares. The circulating water for the coolers is taken from the main condenser injection system. Two 3000-gallon storage tanks and one 3000-gallon reclaiming tank, designed to serve both systems, are provided. The systems also include a lubricating oil reclaiming pump, a lubricating oil heater, and two 300-gallon per hour lubricating oil purifiers.

There is a complete fuel-oil burning system in each boiler-room, which includes two main pumps, one steam-driven emergency pump, one set of heaters, and one drain cooler. The main pumps, which are motor driven, are of the rotary-screw type, and are connected on their suction sides to the forward or after settling tanks, and the fuel-oil transfer manifold, *via* a duplex strainer. They discharge to the burner manifolds. For starting the fires a connection from the oil engine fuel tanks in the forward funnel is provided. Each burner manifold is furnished with a quick-closing cut-out valve. The oil heaters are of the sectional G-fin quadruple marine type, while the drain coolers are of the horizontal G-fin type.

### Make-up Feed and Evaporating Installation

The make-up feed and evaporating plant is so planned that only distilled water is fed to the boilers. The make-up feed is normally drawn to the main or auxiliary condensers from distilled water tanks, which are arranged aft between the shaft alleys, or it is supplied to the deaerating heater as vapour from the fresh-water evaporators. Any sudden demand for make-up feed is met by the make-up feed pump, which draws from the distilled water tank, and has an emergency connection from the reserve feed tanks. It discharges to the deaerating heater *via* the condensate system. There are two fresh-water make-up feed evaporators of the single-effect, vertical, multi-coil submerged type, with a combined rated capacity of 75 tons per day. In addition there are two fresh-water or salt-water evaporators which are duplicates of the fresh-water evaporators, and have a combined rating of 50 tons per day, when fed with salt water. Both evaporators are served by one feed pump. All pumps normally in operation are motor driven, except the feed pumps. The main feed pumps, auxiliary feed pump, and the main circulating pumps are of the turbine-driven centrifugal type. For emergency use steam reciprocating pumps are provided. The turbines which drive the pumps are designed to operate on superheated steam. A central vacuum priming system is installed which serves all centrifugal pumps which have a suction lift, and permits the use of standard pumps without the complication of individual vacuum-producing equipment. This system includes a 25 cubic feet vacuum tank and two motor-driven automatic start-and-stop vacuum pumps.

### Workshop Tools and Air Compressor

A workshop is arranged on the starboard side of the engine-room flat, which is equipped with a complete outfit of engineers' tools. A compressed air system is installed with connections in the machinery spaces and shaft alleys, so that compressed air tools needed for all services can be conveniently worked. The system is served by an air-cooled vertical two-cylinder three-stage air compressor having a designed capacity of 100 cubic feet of free air delivered per minute at a pressure of 150 lb. per square inch.

### Lift Services

There are in the ship eight lifts, five for the use of passengers, one for the engineers, one for the service stores and one for baggage. All the lifts are of the electrically operated type with direct connected single-worm and gear and traction type sheaves. All the passenger lifts are furnished with a floor levelling and full magnetic control. The other lifts have full automatic push-button control, the engineers' lift also has a floor levelling device. For galley and deck pantry services there are eight electric dumb waiters installed.

### Sanitary and Sewage Systems

Cold water at a pressure of 75 lb. per square inch is supplied to all fixtures throughout the ship from a system which is served by two sanitary pumps. The sanitary system is cross connected to the fire main and has a connection to the auxiliary cooling system and an emergency connection to the refrigeration circulating system. All fresh water to the various plumbing fixtures is supplied by two washing water pumps, which are connected on the suction side to the washing water tanks and discharge into a 500-gallon pressure tank. These

pumps are automatically controlled by a pressure-operated switch. Hot fresh water is supplied from two heaters which are arranged in the engine-room and receive their supply from the washing water pressure system. Water is supplied to the fixtures by a circulating system arranged as close as practicable to each fixture. The system is served by two pumps taking their suction from the return main and discharging to the system *via* the heaters. The heaters are of the storage tank pattern.

There is also a separate drinking and culinary water system, which is served by two pumps, which are connected to the drinking water tanks on the suction side and discharge to a 250-gallon pressure tank. All the fresh-water taps arranged in the galleys and also the main and service pantries are served from this system. Iced drinking water is supplied from a branch fitted to the scuttle butt and served by pumps in duplicate.

The swimming pool is filled from the fire main and emptied by the bilge pump. The water in the pool is continuously freshened by make-up from the sanitary system and is warmed by being circulated through a heater. All interior deck drains, plumbing fixtures and soil drains from below the bulkhead deck lead into sewage tanks. One or two sewage tanks are located in each water-tight subdivision and receive the drains in that space. There is fitted a total of thirteen tanks, each served by two pumps of the non-clog type, fitted with self-cleaning sewage screens and each pair is fitted with electric automatic control arranged to operate the pumps alternately.

### Fire Protection Systems

The fire main is served by two motor-driven centrifugal pumps, by the fire and clean ballast pump and the sanitary pumps. Separate systems of mains and risers are provided for hydrants inside the house and for those outside exposed to freezing weather. Pressure is continuously maintained on the inside system and a pressure gauge is fitted in the fire control station to indicate the fire main pressure.

A steam smothering system protects all fuel oil settling tanks, deep tanks and wing tanks. All cargo holds, cargo 'tween decks, cargo trunked hatches, refrigerated cargo spaces, boiler-rooms, paint and oil store rooms and the lamp room are protected by a combined smoke detecting and manually operated $CO_2$ system. The detecting cabinet is located in the fire control station. The emergency generator room and the cinema rooms are protected by independent $CO_2$ systems. $CO_2$ hose protection is provided for the engine-room and boiler-rooms.

### Bilge and Ballast Systems

The bilge system is arranged to pump from all holds and machinery compartments. The two motor-driven triplex plunger bilge pumps, the standby centrifugal pump, the submersible self-priming bilge pump and the two fuel oil transfer and oil ballast motor-driven triplex plunger pumps are connected to the bilge service. Bilge suction valves from all hold compartments are operated by hand at place and hydraulically from controls in the machinery hatch.

There are two separate ballast systems, one for clean and one for oily ballast; that is, for ballast which is placed in fresh washing water tanks or in fuel oil tanks as the case may be. Clean ballast is handled by the clean ballast pump and the fire and clean ballast pump. Connections to the tanks are through manifolds which are combined with those of the washing water system with corresponding valves interlocked. This system is unusually elaborate in that provision is made for pumping tanks when either the engine-room or the forward boiler-room is flooded. This system is also connected so as to supply circulating water to the refrigeration system when the vessel is in dry dock. The oily ballast is handled by the fuel oil transfer and oily ballast pumps. The ballast manifolds are combined with the fuel oil transfer manifolds with corresponding valves interlocked. Bilge and oily ballast water may be pumped overboard direct or to a closed type oil and water separator of about 100 tons per hour capacity.

### Fuel Oil Filling and Transfer

A connection from each fuel oil tank is led to an 8in. loop around the machinery spaces. Oil is pumped by the fuel oil transfer and oily ballast pumps which discharge to the settling tanks and to the loop on either side of the ship. Filling connections from the filling stations, port and starboard, are cross connected and led to each side of the transfer loop. Overflows from individual tanks in each water-tight compartment are led to one or more overflow tanks in the compartment and thence overboard.

### Ventilation, Heating and Air Conditioning

The ventilation air is supplied by fifty supply systems and removed by thirty-two exhaust systems. Air is supplied to all passenger staterooms at an average rate of about 40 cubic feet per minute per person. A change of air is supplied every eight minutes to the public spaces, every six minutes to the crew's living spaces and every 4·5 minutes to the air-conditioned dining saloons. Exhaust ventilation is provided for all public spaces, toilets and showers, galley, pantries, hospitals and all other spaces necessary for the removal of heat and odours. All cargo spaces except the refrigerated cargo spaces have mechanical supply at the rate of one change every thirty minutes, and natural exhaust.

Each boiler-room is ventilated by two 50,000 cubic feet per minute supply fans and the engine-rooms by two 50,000 cubic feet per minute supply fans and by two 25,000 cubic feet per minute exhaust fans which draw from the generator flats, switchboard and operating platform. The refrigerating machinery spaces are ventilated by two 4000 cubic feet per minute supply fans. The boiler-room and engine-room supply fans discharge to their respective spaces through air casings which surround the machinery hatches and are fitted overhead in the machinery spaces. These casings are fitted with numerous outlets to produce a distributed flow throughout so as to minimise the heat transmission to adjoining living spaces.

All ventilation fans can be shut down by the operation of a push button in the fire control station in case of fire, but the fans in the unaffected zones may be restarted locally, if desired. Each ventilation system is provided with a damper which may be closed in case of fire, thus preventing the possibility of a draught up through the ventilation trunks. Ventilation trunks to cargo spaces passing through passenger or crew accommodations are provided with automatic draught checks in the trunk at the boundary of the accommodation space, which are set with fusible links so that, if fire occurs in a cargo space, the draught check will automatically close.

The heating system in the living spaces is designed to maintain a temperature of 70 deg. Fah. with an outside temperature of −10 deg. Fah. The heating of cabin and tourist class staterooms is by warm ventilation air. The main air supply may be tempered by preheaters to 50 deg. Fah. Parallel with the main air ducts is a supplementary system in which the air may be still further heated to a maximum of 160 deg. Fah. The ventilation outlet to each stateroom permits a mixture of the hot and the cool air so that both the volume and the temperature are under the control of the passenger through a simple finger operated knob. In public spaces, other than those which are air conditioned, the heating is done by warming the ventilation air to a maximum of 85 deg. Fah. and is supplemented by steam radiators.

Air conditioning is provided for the cabin, tourist and third-class dining rooms, and for each barber shop and beauty shop for the cabin, tourist and third class. For the cabin and tourist dining rooms the air conditioning units are on the deck underneath the room they serve. The units are of the same size and have a capacity of 8300 cubic feet per minute each. They have a fan section, finned coil steam heating section, brine coil cooling section and an air filter section. Motor-operated dampers control the by-passed air around the coils and another set of motor-operated dampers regulates the outside air and recirculated air from the room. Four independent self-contained air conditioning units are installed for the third-class dining room and one unit for each barbers shop and beauty shop.

### Refrigerating Plant

The refrigerating machinery rooms are arranged in the hold aft of the after boiler-room. The machinery consists of three Freon compressors direct driven by 75 H.P. motors, four Freon condensers, five brine coolers and four Freon liquid receivers.

The compressors are of the vertical single-acting, eight-cylinder V type and have 27 tons capacity on refrigerating duty and 78 tons capacity on air conditioning duty. One compressor, two condensers and one brine cooler take care of the air conditioning and two compressors, two condensers and four brine coolers take care of the refrigeration. The arrangement permits any compressor and condenser to be used for any duty. The plant is served by two condenser circulating pumps, three brine pumps which supply brine to the cargo cold diffuser coils, and the ship's stores spaces, four brine spray pumps which draw from the diffuser sump discharge to the diffuser sprays, two brine pumps which supply brine to the air conditioning units, two brine pumps which supply brine to ship's service boxes and one cargo brine recirculating pump which recirculates brine through the cold diffusers for temperature regulation when maintaining temperatures higher than 10 deg. Fah.

This plant refrigerates about 40,000 gross cubic feet of cargo carried in four compartments at 10 deg. Fah., 40,000 cubic feet of ship's stores in nineteen spaces at various temperatures from 8 deg. to 50 deg. Fah., 1700 cubic feet in seventeen ship's service boxes, makes 2000 lb. of ice in twenty-four hours, and supplies the scuttle butt and the air conditioning units.

There are four cold diffuser units of the brine spray type, one in each cargo space. Each unit has a capacity of 8300 cubic feet per minute and discharges the air to the space through overhead ducts.

### Electric Generating Plant

The main electric generating plant consists of four geared turbo-generators each rated at 600 kW, 120/240 volts, three-wire, D.C. with an overload rating of 125 per cent. for two hours and 150 per cent. for five minutes. The connected load is as follows:—Motors, 3465 kW; galley, 839 kW; lighting, 765 kW; heating and miscellaneous, 268 kW; total, 5337 kW.

The emergency generating plant consists of a 150-kW, 120/240-volt, three-wire, D.C. compound-wound generator coupled directly to an oil engine. It is placed in the dummy forward funnel above the highest deck. Fuel is supplied by gravity from tanks placed in the dummy funnel on a level above the engine, and the generating set is independent of any other auxiliary on the vessel.

### Storage Batteries and Motor Generators

For automatic and instantaneous supply to the "preferred" emergency circuits for light and power, there is provided a 240-volt storage battery with a capacity of 200 amperes continuously for two hours. For the stateroom call bells and other low-voltage interior communication systems there are provided duplicate 24-volt storage batteries. It is estimated that the capacity of each battery is sufficient to operate the system at normal demand for one week. Two batteries similar in type, rating, and arrangement to those for the interior communication systems are provided for the fire alarm system. All batteries are situated in the storage battery room adjacent to the emergency generator room and are automatically kept in a fully charged condition. Two direct/alternating current motor generators, each with an output of 10 kW (15 kVA), 120 volts, 60 cycles, single phase, are provided for power supply to "Selsyn" type telegraphs, cinematograph equipment, and other appliances requiring A.C.

### Distribution and Lighting Systems

The main switchboard is of the conventional "live-front" type with fused lever switches up to a rating of 200 amperes, and carbon circuit breakers for feeders beyond the capacity of 200-ampere fuses, all mounted on marine-finished asbestos lumber panels. On each generator panel is mounted a 3000-ampere circuit breaker, a generator switch, and a full complement of pilot lights, instrument switches, and instruments.

The emergency switchboard is of the same type as the main switchboard and is placed in the emergency generator room. For convenience the interior communication and battery-charging switchboards are combined with the emergency switchboard as one structure, which contains also the automatic bus transfer contactor for battery supply to the preferred emergency circuits.

The emergency switchboard is normally fed from the main switchboard through the interconnecting bus feeder run from an overload circuit breaker on the main board to one side of a double-throw lever switch on the emergency board. Upon failure of the main supply the bus transfer contactor operates instantly and automatically to transfer the preferred emergency circuits to the emergency lighting and power storage battery, and upon restoration of main supply, or establishment of emergency generator supply, these circuits are automatically returned to the generator bus. If the main generator supply cannot be

immediately restored after failure, the emergency generator is started and the general emergency load is connected to the emergency generator by manual operation of the double-throw lever switch.

The main switchboard controls feeders to the emergency switchboard, three "primary" distribution switchboards for lighting and power, the galley power distribution switchboard, to numerous power distribution panels throughout the vessel and direct to a limited number of auxiliaries. From the primary switchboard feeders emanate to lighting distribution panels, power distribution panels, and to certain individual auxiliaries. The arrangement of the distribution system to suit the water-tight subdivision and "fire zoning" of the vessel, the protection of vital cables from damage by fire or collision, and the development of wiring methods and appliances to suit the presently required fire-resisting construction, particularly of stateroom subdivision bulkheads, have constituted the major problems of electrical design for this vessel. The most unusual feature of the lighting system for this vessel is the extensive application of totally indirect lighting and the consequent high total wattage of lamps. Cabin and tourist-class public space lighting is practically all of the indirect type using concealed coves and long troughs extending in some cases the full length of the room. The fixtures in the principal cabin and tourist-class public spaces have alternate lamps arranged on separate circuits to permit subdued and even lighting by the cutting out of one-half of the lamps. In the cabin ballroom, cabin lounge, tourist lounge, and third-class lounge, this system is supplemented by a dimmer arrangement, permitting any degree of illumination from full bright to black-out. In the cabin lounge and ballroom the dimmers are motor operated and remotely controlled by master switches. For the cabin lounge stage, foot and border lights in colour with dimmers are provided.

All staterooms and passages are supplied by two independent circuits so that none of these spaces can be put in darkness by the failure of one circuit. This is in addition to the emergency exit lighting required by law.

Lighting in passenger staterooms, third-class public spaces, officers' and crew's quarters, machinery spaces, cargo spaces, &c., is of conventional type, except for the universal use of anodised aluminium or solid bronze lighting fixtures in lieu of the usual plated finishes. In addition to the usual complement of running, signal, and anchor lights, there are other lights fitted to meet British and German harbour regulations and canal rules. Floodlights are arranged for illumination of the water along the ship's sides when handling lifeboats, and floodlights are provided for illumination of the two stacks. The total number of lighting fixtures is 7278, the total number of lamps is 14,500, of an aggregate of 765,000 watts.

All power equipment, except for certain portable or semi-portable equipment with motors of fractional horsepower rating, operates on 230-volt D.C., and is generally of conventional type; 751 12in., three-speed, oscillating marine type bracket fans are provided. Exclusive of bracket fans, there is a total of 550 motors on the vessel of ratings ranging from ⅛ H.P. to 150 H.P.

### Other Communication Systems

Provisions for interior and exterior communication include unusually complete facilities for the transmission of orders for ship control and navigation, for detection of fire, for alarm in case of emergency and for subsequent direction and control of passengers and crew, for comfort and convenience of passengers, and for radio communication. The most modern navigating equipment is provided, including gyro-pilot, fathometer, pitometer log, and radio direction finder.

For ship control and navigation there are provided electrical self-synchronous telegraphs supplemented by mechanical telegraphs and "sound-powered" telephones supplemented by voice tubes. In addition to its emergency use for indicating dangerously shallow water, the fathometer is used to determine the ship's position by checking the contour of the ocean's bottom indicated by successive depth readings against that shown on the chart. The pitometer log indicates the ship's speed in knots and integrates the distance travelled; with the course recorder chart this instrument provides an accurate basis for dead reckoning when the weather does not permit observations.

The fire alarm equipment is of the latest supervised type and is similar in design to the equipment developed for naval vessels. On account of the fireproof hull construction, thermostats are not fitted in the staterooms, but are fitted in the public spaces, lockers, and store rooms. The general announcing system provides loudspeakers for direct communication from the ship's officers to the fire-fighting crew quarters and to the boat-handling and embarkation stations. This should be of great assistance in preventing panic in case of collision, fire, or other casualty. An independent system is provided for radio broadcasting and making announcements of general interest to the passengers.

The passengers' call bell system consists of "steward" and "stewardess" call buttons in each stateroom registering on local annunciators in the passageways; each of these annunciators has an extension call on group annunciators in pantries; each of these group annunciators has a further extension call on a single central supervisory annunciator that may also be used as the service annunciator during periods of minimum activity.

The wireless equipment is designed for both low and high-frequency transmission, and is arranged for two-way ship-to-shore conversations.

### Conclusion

From the foregoing it will be realised that the "America" is the result of the ideas and the efforts of a great many people. In so large and complicated a vessel, it has required painstaking effort and patience to develop the countless details.

The owners and their representatives have been untiring in their efforts to investigate new materials and new ways of doing things. All this is especially difficult when vessels of this character are undertaken so infrequently and without the aid of a department of the owners which is constantly charged with the more or less continuous development of new designs.

During the time of building there were nearly two hundred approved changes, some of which were quite extensive. Almost all plans took much more time to develop than was expected, and in some instances it was necessary for the Maritime Commission to make final decisions.

From all of this it will be appreciated that it is a matter of some complication to bring to completion the building of a great passenger vessel, especially under recent safety laws and regulations. However, now the "America" is in service, there is every reason to think that she will be a vessel in which Americans may justly take pride.

During her official acceptance trials, which were made last June, the "America" improved upon the specified speed and power consumptions laid down, and her fuel consumption per shaft horsepower was less than that guaranteed by the builders to her owners. Her three four-day vacational voyages from New York to the American West Indian Islands have demonstrated her seaworthiness and her suitability for the purposes for which she was designed. When circumstances allow the "America" to take up her normal Atlantic service, we shall look forward to seeing this fine ship. The "America" recently left New York on her fourth voyage to the West Indies.

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## The Static Friction of Lubricated Surfaces*

By A. FOGG, M.Sc., and S. A. HUNWICKS, B.Sc. (Eng.).

### Introduction

The primary object of carrying out this investigation was to obtain information on "boundary" friction and the "boundary lubricating" properties or "oiliness" of various substances.

The two chief properties of fluids which determine their lubricating value are viscosity and some other property, independent of viscosity, usually known as "oiliness." Under static conditions any effect due to viscosity must necessarily be absent, since, by definition, viscosity is that property of a fluid which determines the resistance of the relative sliding motion of adjacent layers. The only resistance to the commencement of motion, therefore, is that due to the attractive forces between the solid surfaces as modified by the layer of lubricant between them. The effectiveness of this layer, known as the boundary layer, in reducing the attractive forces becomes a measure of the boundary lubricating properties of the lubricant which must be closely associated with "oiliness."

By means, therefore, of measurements of the resistance to the commencement of motion, *i.e.*, the static friction, a direct measurement of a property associated with oiliness can be made.

The exact mechanism of the boundary layer when motion has begun—for instance, whether it is still due entirely to the attractive forces of the surfaces, or perhaps to bending of the molecules in the boundary layer—is not known, but there is no doubt that the value of the static friction has a direct bearing on the quality of a lubricant.

As a further object it was hoped that, if the method of test proved successful, it would provide a reliable and simple means of making tests for boundary lubricating properties of oils on a more exact basis than has been possible heretofore.

At the present time the only satisfactory method of test for the quality of a lubricant is a prolonged test under working conditions which is generally fairly costly. In many applications it is known that viscosity is a factor of importance and a flat viscosity-temperature curve is desirable. In some cases chemical stability is important, but in practically all cases, in varying degrees, the property of oiliness plays a vital part.

It appears, therefore, that in order to assess the value of a substance as a lubricant it is necessary to consider, at least, the following three factors:—

(1) Viscosity-temperature and possibly viscosity-pressure relationships.
(2) Chemical stability.
(3) Lubricating value under boundary conditions.

The present investigation deals only with the last of these, and it must be realised, therefore, that if, as a result of this investigation, a substance is found to have good "oiliness" properties, it does not necessarily follow that this substance is a good lubricant for all conditions.

### Apparatus

Probably the most familiar apparatus used in static friction measurements, and one which is in use in the commercial testing of lubricants, is the Deeley machine. This machine was designed many years ago for the study of "oiliness" characteristics and the variations in frictional resistance produced by different combinations of metallic surfaces. One of these machines was available when the present investigation was begun, and it was decided to explore its possibilities for the work. Many experiments had been carried out at the N.P.L. with this machine by different experimenters, but the machine had never been adopted as a regular testing machine because of the lack of consistency in results obtained under apparently identical conditions. For instance, with given surfaces, lubricant, and a fixed load, consecutive measurements of coefficient of friction have been found to vary by as much as 200 per cent. It is well known that an adsorbed boundary layer adheres strongly to a metal surface, and great difficulty is experienced in removing it. In the operation of the Deeley machine there has always been some uncertainty as to whether or not the adsorbed layers have been removed and the surfaces rendered clean before proceeding to another lubricant.

The arrangement of contact of the two opposing friction surfaces was also considered as a possible explanation of the inconsistency of the results obtained. The friction surfaces consist of three flat pegs, equally spaced on a circle on the underside of a carriage, resting on a disc. With this arrangement it is necessary, for similarity of contact of each of the pegs with the disc, that the flat bearing surfaces of the pegs lie in one plane, a condition which can never be achieved exactly in practice. (It is not easy to see, however, why variations from the uniplanar condition should influence appreciably observations in the static boundary condition.)

As a result of these considerations, however, it was decided, first, to replace the three flat pegs by three balls, so that the condition of each contact should be the same and, because of the high intensity of loading at the contact areas of balls, the separating layer of lubricant should be reduced to the limiting molecular layer; and secondly, to endeavour to develop a technique of cleaning the surfaces which would at least ensure that a standard condition of cleanness is arrived at before a set of measurements is made with any lubricant.

A description of the apparatus with the above modification is as follows. It consists of the two opposing surfaces, one, a disc about 4in. diameter, and the other three ¼in. diameter balls equally spaced round a circle 3in. diameter on the underside of a circular carriage. (The material used for the friction surfaces throughout this investigation was hard steel.)

The carriage engages with a torque measuring device consisting of a coiled spring with indicating mechanism. The pressure between the surfaces can be varied by loading the carriage with weights. The disc, *i.e.*, the lower friction surface, is carried in a bath which contains the lubricant under test, and a gas ring is provided under the bath for heating the oil, the temperature being measured by a thermo-couple in the oil bath.

The machine is operated by slowly rotating the disc by means of an electric motor and gearing, the

* Reprinted from the *Journal* of the Institute of Petroleum—Abstract.

motor being mounted separately from the machine so as to reduce vibration to a minimum. The frictional resistance between the surfaces causes rotation of the carriage against the action of the spring, and the disc is rotated until slipping of the surfaces occurs, when a pawl and ratchet mechanism prevents the spring from unwinding. The torque produced by the spring on the carriage at slip is thus equal to the friction torque, and, as the total load is known, the coefficient of friction is easily obtained.

### CLEANING THE SURFACES

Most of the lack of agreement between the results of static friction measurements of various investigators can probably be attributed to failure to remove all traces of contamination from the metal surfaces before introducing another lubricant. The usual method adopted has been to use a solvent, and many such substances have been used with varying degrees of success. It appears, however, that this method is fundamentally unsound, and it is submitted that such a procedure can at best only result in the contaminating layers being replaced by an adsorbed layer of the solvent or some of its more active constituents. Extremely volatile solvents might be expected to give the nearest approach to absolute cleanness, but if the generally accepted conception of surface forces applies, it would appear that even with such solvents attachment between surface molecules and solvent molecules would take place.

In view of these considerations it was decided to make a comparison of the static friction of hard steel surfaces when "cleaned" by various solvents or cleaning solutions, and when treated in such a manner that an actual layer of material was removed each time from the surfaces.

For this latter purpose it was decided to rub the friction surfaces with the finest grade of emery paper available, "0000 blue back"—first removing surplus oil by means of trichlorethylene vapour—after the surfaces had been contaminated with various substances, and to determine the consistency of the results obtained after this treatment. The disc, *i.e.*, the lower friction surface, was rubbed on a sheet of the abrasive paper placed on a surface plate in order to maintain a flat surface. Measurements of the friction were made as quickly as possible after this treatment, and without handling the surfaces. In all, several hundreds of such observations were made, and the coefficient of friction was always between 0·56 and 0·60, with a mean value of 0·58. On a number of occasions the surfaces were left in the machine and, without contamination except from the atmosphere, the coefficient of friction $\mu$ measured at short intervals of time up to one hour. At the end of this period the value of $\mu$ was still above 0·50 showing a very slow rate of contamination.

The first solvent tried was trichlorethylene, both in liquid and vapour form; this substance is marketed commercially as a degreasing agent, and a vapour degreasing plant was used for the vapour cleaning process. With liquid cleaning the value of $\mu$ was 0·33, and with vapour cleaning 0·45. These values, and those following for other solvents, are the mean of several obtained after cleaning surfaces contaminated with a number of oils chosen at random.

The second solvent used was industrial alcohol (95 per cent.). The mean value of $\mu$ obtained was 0·43.

The cleaning process used by Hardy in certain static friction measurements was then used. This process consisted of removing gross impurities by ordinary benzene or alcohol, rubbing the surfaces on a piece of wet felt sprinkled with chromium sesquioxide, rinsing under the tap to remove finer particles of chromium sesquioxide, drying with clean filter paper, and finally immersing in absolute alcohol just heated to boiling point; whilst still hot the surfaces were removed with clean tongs, rinsed twice with absolute alcohol and dried by draining. Before using this process the surfaces were covered with a light machine oil. After cleaning the mean value of $\mu$ was 0·49.

A further cleaning process used by Tomlinson, consisting of rubbing the surfaces, after the removal of surplus oil, with the finest quality cotton wool and a mixture consisting of 8 parts absolute alcohol, 2 parts ether, and 1 part ammonia was next used. The value of $\mu$ obtained was rather variable—a new position being used for each observation—ranging from 0·40 to 0·55, with a mean of 0·48.

None of these cleaning methods therefore appears to be as efficacious as the abrasive method. The latter may not, of course, produce a state of absolute cleanness; but since it gives a condition of higher and more consistent friction than any of the other methods, it is obviously a more desirable method to apply.

It might be argued that the abrasive method of cleaning produces a roughening of the surfaces, and thus gives a somewhat artificial value of $\mu$. A number of further observations which were made on the above solvents appear to contradict this and give further support to the submission that any solvent cleaning method will leave an adsorbed layer on the surface. Having obtained a number of consistent values of $\mu$ of the order of 0·58 for the steel surfaces cleaned by the abrasive method, the above solvents, namely, trichlorethylene, alcohol, and the alcohol-ether-ammonia mixture, were each in turn placed on the clean surfaces and the coefficient of friction measured. With liquid trichlorethylene the value of $\mu$ was 0·33, with alcohol it was 0·43, and with the alcohol-ether-ammonia mixture it was also 0·43; as compared with 0·33, 0·43, and 0·48 for each of these, respectively, when used as cleaning solvents.

In other words, the friction of the surfaces when flooded with the above substances is the same as when the surfaces are cleaned with these substances and the surplus is removed.

The amount of rubbing to produce the clean condition ($\mu$=0·58) was generally very small, except in those cases where there had been obvious chemical action between the lubricant and the surfaces.

An interesting experiment was made to determine the extent of contamination due merely to handling the surfaces after cleaning to the "$\mu$=0·58 condition." The friction disc and the balls were lightly rubbed with the fingers, the hands being in a normal state of cleanliness and having had no contact with oil or grease since washing. The coefficient of friction, measured immediately afterwards, was 0·10. This result demonstrates the ease with which surfaces become contaminated and the enormous effect on the coefficient of friction. As will be seen later, the value of $\mu$ is of the same order as was obtained for animal and vegetable oils, and presumably the contamination resulted in an adsorbed layer of similar fat or oil from the human body. When an oil was applied to the clean surfaces an additional precaution was taken against contamination from any other source. After the friction of the clean surfaces had been measured they were rubbed with a mixture of emery and the oil to be tested wiped with a piece of clean dry "Selvyt" to remove loose abrasive particles, and then finally immersed in the oil. This assured that the oil was present on the surface, available for adsorption as soon as the abrasion was finished.†

### EFFECT OF SIZE OF BALLS

A number of observations were made at various loads with ¼in. and ½in. diameter steel balls using oleic acid as lubricant. Measurements of friction were made to temperatures up to 100 deg. Cent. with both sets of balls, but there was no appreciable variation with either set at any of the loads or temperatures, the value of the coefficient of friction being in all cases between 0·08 and 0·09.

It was decided to adopt the ¼in. diameter size for all the work included in this report, but it is intended at a later stage to investigate the effect of curvature more fully.

### TEMPERATURE AND LOAD

In all cases where it was safe to raise the temperature of the lubricant without danger of fire or explosion, observations of friction were made up to about 100 deg. Cent. with temperature rising and falling.

With regard to load, preliminary observations were made with total loads on the carriage (including the weight of the carriage) ranging from 0·738 lb. to 5·904 lb., in order to determine the effect of variations in load. No appreciable variation with load over this range was obtained at any temperature; this independence of coefficient of friction with load is usually taken as evidence of complete boundary conditions. For all subsequent work the load was fixed at 3·690 lb., this being a convenient load for ease of operation of the machine.

The load of 3·690 lb. represents, according to Hertz's theory of elastic deformation, a mean pressure between the balls and ring of 30·3 tons per square inch and a maximum pressure of 45·5 tons per square inch.

### SUBSTANCES USED FOR LUBRICATING THE SURFACES

The substances selected were, for the most part, recognised lubricants, but a number of common liquids were also included. A list of the substances used, divided into classes, is given below.

(1) Straight lubricating oils, ranging from fatty oils to highly refined mineral oils. At each end of this range oleic acid and B.P. paraffin were included, the former being typical of the active constituent of fatty oils and the latter as representative of the inactive constituent of mineral oils and the result of ultra-refining.
(2) Extreme pressure lubricating oils.
(3) Graphited oil and compounded oil.
(4) Common liquids.

When the observations had been completed no correlation was observable between viscosity characteristics and the friction results. The better known of the substances gave friction characteristics in an order similar to that generally accepted for the "oiliness" value of these substances, for example, all fatty oils were superior to all mineral oils, irrespective of viscosity.

A series of experiments was then carried out to determine the relationship between molecular weight and coefficient of friction. These results proved extremely interesting, and form the subject of a separate paper.‡

*(To be continued)*

† A similar method was used by S. Livingston Smith and E. Glaister in experiments on the original form of Deeley machine. In these experiments the lower surface, which was a cast-iron disc, was prepared by washing in benzol and then spraying with hot water to remove all traces of oil. After drying it was lapped with flour carborundum and the oil to be used. (See "The Effect of Use on the Properties of Motor Oils," S. Livingston Smith and E. Glaister. THE ENGINEER, May 1st, 1931, p. 476.)

‡ "A Note on the Mechanism of Boundary Lubrication suggested by the Static Friction of Esters," by A. Fogg, *Proc. Phys. Soc. Lond.*, 1940, Vol. 52.

## Flameproof Resistances

OF considerable interest to collieries and industries requiring flameproof gear is an entirely new pattern flameproof resistance (designated type M T R) developed by the Metropolitan-Vickers Electrical Company, Ltd., Manchester. It has been passed by the Mines Department Testing Station at Buxton under the certificate F.L.P. 1424 as flameproof against explosive gases groups 1 and 2 (methane and petroleum vapour only). The proportions are such as to provide high heat-dissipating capacity in so compact a form as to render these resistances particularly suitable for installation along a mine roadway or in similar positions where the saving of space is important. A three-unit set is illustrated in Fig. 1. The resistances are of tubular form and are supplied in three-unit and five-unit assemblies, or in combinations of these, mounted on channel iron bases.

FIG. 1—THREE-UNIT FLAMEPROOF RESISTANCE

The flameproof steel tubes containing the resistance windings are supported at one end by a vertical bracket and at the other end they are sealed by flanged mounting rings into the terminal chamber shown in Fig. 2, in which the terminal arrangement can be clearly seen. The resistance material itself is wound in grooves on substantial formers supported on a steel rod. It is designed to be as near the inner surface of the tube as circumstances permit, and the intervening space is filled with quartz sand of high dielectric strength, all with a view to promoting heat dissipation. The inside of the tube is lined with a vitreous enamel as additional insulation. Connections between adjacent formers are made by copper strap bolted to terminals supported on the formers, the leads from the tapping points to the main terminals being made of stout copper rod running through axial holes in the grooved formers. Where more than five tubes are required, two or more sets of units are combined side by side, their terminal chambers being bolted together and connections from one to the other made through specially designed flameproof bushings. All interconnectors are included and only external leads from the motor or controller require to be made on site.

FIG. 2—TERMINAL CHAMBER

An example of a composite set is illustrated in Fig. 3, which shows a bank of five sets of five-unit M T R resistances for a 250 H.P. installation for main-and-tail haulage in a colliery. The dimensions of the whole bank are 3ft. 4in. height, 6ft. length, and 5ft. 4in. width.

External connections are effected by sealing boxes and armour clamps, allowing the outlet to run in any one of five directions. For a bank of

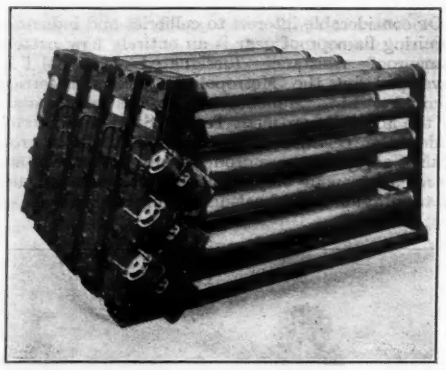


FIG. 3—COMPOSITE SET OF RESISTANCES

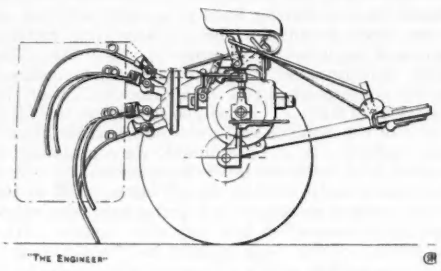
three units, a maximum of five sealing boxes plus one for each additional terminal chamber is permissible, and for the five-unit bank, six chambers, regardless of the number of terminal chambers. Pipe glands may be employed instead of sealing boxes for petrol vapour, but not for methane. The M T R resistances are designed for voltages up to 600.

## Rear-Action Swath Turner and Windrower

THE new swath turner for hay crops made by Bamfords, Ltd., of Uttoxeter, and illustrated by a half-tone engraving and drawings, has been designed with a view to obtaining lightness of draught combined with the advantage of being able to follow closely the ridges and furrows of the ground. With this end in view the driving and controlling mechanisms for the rake tines have been combined in two separate units which are individually adjustable either round the driving shaft or in a transverse direction as will be described. The units are disposed parallel with and above the road wheel axle, and are mounted on a secondary rotating shaft driven by the motion of the road wheels through gearing, the road axle itself being stationary. There are several advantages in this arrangement, as the driving gears are placed slightly to the front of the road wheel axle which counterbalances the weight of the tines and their controlling gearing. Lightness of draught is thus obtained whilst the tines being mounted near to the road wheel axle are enabled to follow ridge and furrow without the use of the usual trailing furrow wheels.

As will be seen from the diagrams the tines themselves have a certain limited vertical movement in slotted brackets attached to the controlling pins. This vertical movement allows a sweeping movement of the tines on the ground and also avoids straining or breaking of the tines owing to irregularities of the surface. The high point of attachment of the tines gives the rake heads maximum capacity and enables them to deal easily with the largest crops, whilst the advantage of a stationary road wheel axle is that strands of hay are prevented from winding round it and causing clogging.

The machine has a balanced drive from both road wheels so that when turning corners both heads are driven at a uniform speed, and it also has a wide wheel base and low seat, making it very suitable for working on hill sides. The driving gearing, as already mentioned, is mounted on a live transverse shaft having a bevel wheel for each raking head in driving connection, whilst a rake-actuating shaft is provided on which are mounted two bevel pinions engaging with the bevel wheel on the driving shaft. The rake-actuating shaft it disposed at right angles to and slightly above the driving shaft. The bevel pinions

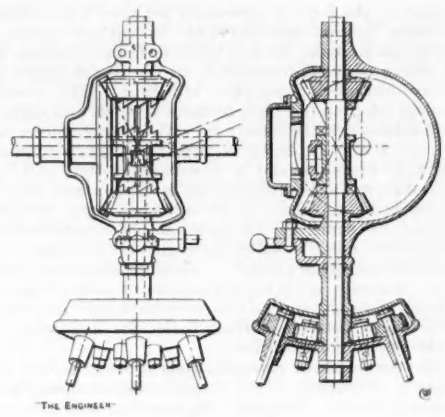



SIDE ELEVATION OF SWATH TURNER

are provided with skew teeth which engage the teeth of the bevel wheel on opposite sides of its axis. The skew teeth of the two bevel pinions, when in their working positions, are inclined in opposite directions and are loosely mounted on their shaft.

Each of these two bevel pinions has formed on its inner side clutch teeth, and a sliding clutch member with clutch teeth on each end is mounted between them. This clutch member has a driving connection with the rake-actuating shaft, an operating lever being provided for engaging the double-ended clutch with one or other of the bevel pinions according to which direction it is desired to drive the rake heads, or to adjust it to a central neutral position when both bevel pinions will idle round their shafts and the rake heads will be stationary. These reversible pose of collecting two swaths into one windrow.

A foot pedal is fitted which actuates a lever fixed to a cross shaft secured on the upper part of the frame, the heads being connected to this shaft by two lifting levers so that when the shaft is rotated by depressing the foot pedal the rake heads are lifted simultaneously, the movement of the tines in a downward direction being adjustable by a cotter passing through holes in the foot pedal quadrant. For retaining the rake heads in the raised position a loop is attached by a bracket to the forward part

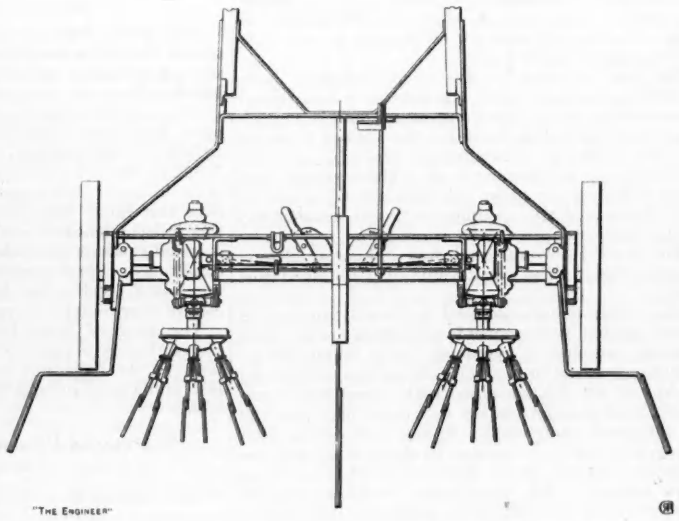



GEAR-BOX

of the frame. This loop is pivoted so that it can be swung into or out of action as desired. When in action it automatically engages and slides over a projecting member which is attached to and rotates with the lifting lever cross shaft, thus holding up the rake heads.

Adjustment of the heads in a transverse direction to accommodate various widths of swaths is accomplished by means of two levers pivoted to two horizontal plates. One end of each lever has a link which connects it to a lug on the side of the gear-box of the rake head. The horizontal plates are slotted and the levers retained in their adjusted positions by passing a cotter through a hole in the lever and through the appropriate hole in the slotted plate.

REAR-ACTION SWATH TURNER




PLAN VIEW OF SWATH TURNER

The gears are enclosed in a dustproof and oil-tight casing and the gears work in an oil bath.

The rake-actuating shaft projects through a bearing in the side of this casing and carries the controlling head for the tines consisting of epicyclic gearing encased in a dustproof housing through which project the pins on which the tine brackets are mounted, the action of the controlling gears keeping the points of the tines always downwards. The epicyclic gearing consists of a stationary gear arranged concentrically with the rake-actuating shaft to the bearing of which it is secured. Intermediate rotating gears engage, on the one hand, with the stationary gear, and on the other with outer rotating gears on which are mounted the pins carrying the tine brackets.

The central stationary gear wheel is connected to a lever by which it can be turned around its axis for the purpose of varying the angle of the tines from the vertical. This lever is secured in the adjusted position by means of a bolt to a lug on the casing of the reversible gearing. It will thus be seen that both rake heads may be rotated in either direction according to whether it is following a right or left-hand cut mower, or the rake heads may be set to turn in opposite directions for the purThree windguards are supplied with the machine which are fixed on the frame of the machine as shown in the drawings.

OIL FROM OLD WELLS.—Oil is to be obtained from old oil wells through the application of a method developed by scientists at the Mineral Fuel Institute of the Academy of Sciences of the U.S.S.R. According to Mr. A. B. Sheiman, head of the group engaged on this work, only about 25 per cent. of the oil in a well is extracted by ordinary methods and 75 per cent. remains in the ground. The new process of restoring a well is based on the following principle:—Air under pressure is heated to 500 to 600 deg. Cent., in which state it is blown into the oil stratum. Under pressure of the stream of hot air the oil is easily separated from the sand strata. The oil is carried by the air stream to the working well 300ft. to 650ft. away. Gas is sucked up by a vacuum pump and oil by an ordinary pump. With an experimental installation of small capacity, 20,000 tons of oil, more than 353 million cubic feet of gas, and about 500 tons of benzine were extracted during the past few months from an area 74 acres in extent. At present equipment calculated for obtaining oil, gas and benzine through the reworking of an area of 247 acres is nearing completion in the Maikop district of the Krasnodar Province. The new method is also to be employed in other regions of the Soviet Union.

# Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

### Licences for Building and Constructional Work

The First Commissioner of Works has issued a memorandum explaining the way in which it is proposed to administer Defence (General) Regulation No. 56A, which establishes a system of licensing building and constructional operations and comes into force on October 7th. There were issued simultaneously with the memorandum certain regulations by the Iron and Steel Control which have made some modifications in the delivery scheme brought into operation last April, which has now been made to dovetail into the Office of Works scheme for the control of civil building and constructional operations. Whilst there is no fundamental change in the delivery scheme of last April, it was found that there were leakages of steel which was used in certain building operations not essential to the carrying on of the war. The intention behind the memorandum is to tighten up the use of steel for national purposes. The memorandum of the Office of Works points out that no work of building or civil engineering construction may be undertaken or continued without the consent of the appropriate authority. Consent must be obtained for work in a number of categories, including the construction, reconstruction, or structural alteration of a building, railway line, siding, and other fixed works of civil engineering. No consent is required if the estimated cost of the undertaking or completion of the work involved does not exceed £500, or if the work is being done on behalf of a Government Department or in pursuance of a contract for the work made with a Government Department; if a Government Department has agreed to pay the cost, either wholly or in part, or if the work is being done by a local authority in discharge of its functions under the Civil Defence Acts; if it is in the nature of maintenance, running repairs, or decorations, or if the work falls within any of the categories set out in the appendix to the memorandum. The granting of an authorisation or licence does not mean that controlled materials will automatically become available for the work. It is pointed out that Regulation 56A also applies to Scotland, so that the memorandum also applies to work in that country.

### The Pig Iron Market

The position regarding supplies of pig iron is generally satisfactory, although there may be some difficulty in obtaining precisely the kind of iron which a consumer may require. The heavy demands of the steel makers for basic and hematite pig iron necessitate the producers concentrating largely upon these qualities, but there has been an expansion of late in the call for foundry grades, and the hope is expressed that larger supplies of special ores will be available shortly so that the production of low-phosphorus and hematite irons may be improved to meet the growing requirements of the heavy engineering foundries engaged upon munition work. The latter are receiving regular supplies, chiefly owing to the careful supervision exercised by the Control. The stringency is perhaps most noticeable in the supply of low-phosphorus iron, but this has been a feature of the market for some time, and although it is understood that production has been increased the demand appears to have expanded to at least an equal extent. The available quantities of high-phosphoric foundry iron are sufficient to meet the full demand, although owing to the increasing number of light castings makers employed upon Government work the use of this metal is much heavier now than a few weeks ago. Most consumers of foundry iron appear to have experienced some difficulty with regard to mixtures, and help is being given by the Control in arranging suitable grades for consumers' needs, although naturally there is a limit to which this is practicable. There is also some tightness in the supply of hematite iron, the demand for which is somewhat in excess of production, and it is expected that imports of this quality and of low-phosphoric iron will be arranged to satisfy consumers' needs. For some time there were complaints that there was not sufficient forge iron available for the consuming industries, but this period seems to have passed and the position on this score is now satisfactory.

### Scotland and the North

The activity in the iron and steel trades in Scotland is well maintained. Practically all branches of the consuming industries are fully employed upon war work and their requirements show a tendency to expand. The heavy steel works are operating under great pressure and there is an insistent demand for practically all the products they turn out. The raw material situation is satisfactory and supplies of scrap are now reaching the works to an extent which has led to some congestion. The requirements of Government Departments and firms engaged upon war work are so heavy that they absorb practically all the material produced, and there is little surplus left for export. The efforts, however, of the authorities to foster overseas business have resulted in a certain amount of steel being made available for firms engaged upon the manufacture of goods for export in which steel is required. The shipyards are taking up a large proportion of the Scottish steel production and there is not likely to be any decrease in the demand from this industry for many months, since a large programme of work is in hand. The constructional engineers are also taking up all the available tonnages of joists and sections and the output of this class of material is upon a huge scale. The tightness in the plate position persists, although large quantities are being produced. The tank makers, locomotive builders and other consuming industries, however, are obtaining regular supplies, although not in the quantities they would like. In the Lancashire district consumers are pressing for deliveries of all classes of steel. There is a heavy demand for bars, large and small, whilst in spite of the fact that some of the constructional engineers are not so busy as they were a short time ago, the call for joists and sections of all sizes is insistent. The electrical engineering industry is also taking large supplies and the same applies to the machine toolmakers. Business in alloy and special steels is maintained at a high level.

### The North-East Coast and Yorkshire

Whilst it is admitted that the intensification of the air hostility has presented the steel works with some problems, the steps which have been taken by employers and workmen's organisations have prevented any serious interruption in outputs. The demand has not slackened in any way and for many weeks past has been rather in excess of production. As a result the important arrivals of American semi-finished and finished steel have been welcomed, since they have provided much-needed relief for the producing works, as well as easing the situation to consumers. The re-rollers in particular have benefited from these imports, as they had reached a stage at which they were missing the supplies of Continental material to which they had been accustomed. Their position is now comfortable, excepting that larger supplies of 1½in. and 2in. billets would be acceptable. The majority of the re-rolling mills, however, are now being operated at capacity; but any effort to accumulate stocks of semis is discouraged by the Control. The works producing heavy finished steel are also operating at capacity and their entire production passes into immediate consumption. Consumers not engaged upon work coming under the heading of national importance still have great difficulty in obtaining supplies, as they have to give precedence not only to firms engaged upon war work, but also to those manufacturing goods for export. Conditions in the Yorkshire industry are representative of the position in other parts of the country. The call for basic steel is undiminished and all the works are experiencing great pressure from consumers anxious to obtain material. The requirements of the constructional engineers are perhaps slightly less than was the case a month or two ago, but the demands from the shipbuilders, marine engineers and general engineering firms employed upon munitions are greater and continue to expand. There is also a heavy demand for alloy and special steels and the request for bright steel bars is a noticeable feature of the market.

### Copper and Tin

Interest lately has centred upon the American copper market, which has developed a very strong tone. The heavy buying wave of a week or two ago was followed by a lull, but the pressure of demand arising from the American rearmament programme which is now beginning to affect the market has quickly changed the position. Buying has been on a heavy scale, and the customs smelters have now raised their price to 11·50 cents, which is the same level as that quoted by the primary producers. There is also a tendency on the part of the manufacturers to spread their sales over the market, and the belief prevails that a good deal of this recent buying has been in advance of requirements, and due to expectations that a heavy demand will arise from rearmament orders. It is expected that the sales in August and September will constitute a record. There is a possibility that the customs smelters have not such well-filled order books as the big producers, and this may check the tendency for prices to rise above their present level. According to the statistics of the American Copper Institute, the smelter output in August was 79,926 short tons, compared with 79,723 tons in July. The refined output dropped to 80,851 tons, compared with 90,995 tons. The August deliveries, however, jumped to 96,383 tons, against 71,226 tons in July. At the end of August the refined stocks were 198,730 tons, compared with 215,823 tons in the previous month. The British copper position is sound, and there seem to be ample supplies to meet the very heavy demands of the industries engaged upon war work. Supplies are readily obtainable, and firms have no difficulty in filling their requirements. . . . This week tin prices sharply rebounded from the low levels to which they had fallen. Conditions in the market were distinctly dull last week, and the quotation fell to £239 10s. for cash and £243 for three months. This was due to hedging sales by the producers and to a certain amount of speculative realisation. When the sales by smelters ceased prices recovered and values further appreciated upon the intimation by the Ministry of Supply that export licences would be more freely granted for shipment in November and following months. The contango has expanded to about £4, or, roughly speaking, to a working average of 6 per cent. The fact that tin is uninsurable and that traders are disinclined to hold stocks in the present circumstances may give the market an easier tone later on, but at present the tendency is for prices to advance.

### Lead and Spelter

The situation in the lead-consuming industries in this country remains comfortable, in spite of the increased demand for war purposes arising out of the acceleration of the output of aircraft and mechanical vehicles. Firms engaged upon war work are receiving regular supplies, and the demand from this quarter more than compensates for the loss of peace-time orders. Large supplies of scrap lead also exist in this country, which are being taken up so far as is possible, although some disapproval is expressed at the high character of the Government's specifications. In the United States the position is rather unusual; whilst the market is firm and the producers have healthy order books it is reported that stocks in that country are the lowest for some years, and at the end of August they amounted to 47,000 tons, which is only about one month's supply. The price, however, is retained at 4·90 cents New York, and it is anticipated that as the rearmament programme in America develops there will be a heavy demand for this metal. . . . The spelter position in this country has not deteriorated. The demand is maintained at a high level and has been affected to only an insignificant extent by air raids. Supplies are readily available to all works engaged in the war effort. Practically all the consuming industries are employed upon work directly or indirectly connected with the war, and the Control sees to it that these firms receive their full requirements. After the war industries those works requiring spelter for the manufacture of exportable articles receive attention, and there is still some left for ordinary commercial requirements. The brass industry is particularly busy and is consuming large quantities of metal, while the galvanisers also are taking up important tonnages. In the United States the market is firm, and large orders have recently been realised in connection with the American rearmament programme. Whilst the price has not yet been advanced, the impression prevails that an upward movement will occur before long.

## British Standards Institution

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.*

### PORTLAND AND HIGH ALUMINA CEMENT

B.S. Nos. 12 and 915. A new edition of B.S. 12, Portland Cement, has been issued. There are two major features of the revision. One is the amplification of the specification to include cement of the rapid-hardening type for which there has so far not been a specification. The other is the replacement of the test for determining the tensile strength of a standard briquette by a compression test on a cement-sand mortar cube. The desirability of making this change was mentioned in the Foreword to the 1931 edition. Since that date the compression test has been the subject of further investigation, both at the Building Research Station and also by a panel of experts. It has been found to give results with different gaugers more consistent than those obtained by the tensile test, whilst another advantage is that the strength of the mortar cubes can be related to that of concrete made with the same cement. The cement mortar cubes are compacted in a specially designed vibration machine, which is illustrated by a photograph and fully dimensioned drawings. As it is appreciated that the adoption of the new test will require the installation of the appropriate testing apparatus, the tensile test has been retained for use when specially required.

It was considered desirable for the specification for high alumina cement to form the subject of a separate document, and that it should not be embodied in B.S. 12. B.S. 915 has accordingly been issued. The general form of the specification follows the same lines as B.S. 12, but in this case, as there was no traditional tensile test, the compression test has been included, without the alternative of a tensile test.

### TESTING INCOMBUSTIBLE MATERIAL

BS/ARP 47. This specification has been prepared in response to a demand for materials and treatments of comparatively low cost which would afford a useful degree of protection against incendiary bombs, although not necessarily as high as that required of materials conforming to BS/ARP 27, Testing Incombustible Material Resistant to Incendiary Bombs. The specification fixes a standard of protection such that materials conforming therewith will:—(*a*) Markedly reduce the lateral spread of fire on protected surfaces; (*b*) markedly retard or even prevent entirely the outbreak of a destructive fire; (*c*) markedly reduce the damage to protected timber floors usually confining it to the slow burning and charring of a square foot or so of boarding. It is emphasised, however, that the adoption of protection to the standard fixed by this specification does not obviate the necessity for active defence against bombs by the stirrup hand pump or other fire-fighting appliances. By retarding the effects of the bomb the time during which a bomb or resultant fire may be effectively dealt with is appreciably extended. Further, when a bomb has ignited in a protective space charring of the protected timber will have occurred and glowing timber may be present. It is essential therefore that after the bomb has been extinguished, the protective material must be removed locally and access then made to the underside of the timber so that effective measures may be taken to extinguish any smouldering that may be present. Price 4d. post free.

### FLAMEPROOF ELECTRIC LIGHTING FITTINGS

B.S. 889—1940. This specification covers well glass fittings and bulkhead fittings intended for use where the following inflammable gases or vapours may occur in explosive mixture with air:—Group I, Methane; Group II, Petroleum Vapour Acetone Vapour; Group III, Town's Gas or Coke Oven Gas Containing Not More than 60 Per Cent. Hydrogen. Portable headlamps connected to the circuit by flexible cord are not provided for in this specification. Such lamps are not at present accepted for certification by the testing authority. The dimensions are very carefully specified, and durability, hydraulic, impact and thermal shock, and temperature rise tests are provided for. The flame-proofness has to be in accordance with B.S. 229.

LOCAL IRON FOR KUZNETSK WORKS.—A large iron ore mine, to be known as the Tashtagol Mine, is being built in Gornaya Shoria, in the Kuznetsk Basin of Siberia. The new mine will supply the Kuznetsk metallurgical works with local ore, the reserves of which in Mount Tashtagol are estimated to amount to 33 million tons, the ore containing on an average over 50 per cent. of iron. The Tashtagol Mine will be completely mechanised. Before the ore is delivered to the surface it will pass through an underground crushing plant. By the end of the year the Kuznetsk works will be supplied with the first 100,000 tons of Tashtagol ore.

# Notes and Memoranda

## Rail and Road

FEDERATED MALAY STATES RAILWAYS.—The revenue from all sources on the Federated Malay States Railways during the month of June last was £175,950, as compared with £118,606 during the corresponding month of 1939. The total revenue for the first six months of this year was £1,103,444, compared with £802,752 for the corresponding period of 1939.

SOVIET–FINNISH RAILWAY AGREEMENT.—According to a Moscow announcement, a new agreement regarding rail communication between the Soviet Union and Finland was recently signed in Moscow. The agreement provides for direct passenger and freight traffic between the two countries, for transit traffic between Russia and Sweden, *via* Finland, and for rail communication with the Hangö Peninsula leased to Russia under the Soviet–Finnish Peace Treaty.

SOUTH AFRICAN RAILWAY IMPROVEMENTS.—It is recorded by the *Railway Gazette* that progress is being made upon the various deviations on the Cape Eastern main line. The deviations, aggregating 70 miles in length, between East London and Queenstown, are being undertaken in order to reduce the ruling gradient from 1 in 40 uncompensated for curvature—equivalent to 1 in 33 compensated—to 1 in 50 compensated; to ease the sharpest curves from 330ft. radius to more than twice that radius; to shorten the distance between Amabele and Imvari by about 16 miles; and to reduce the total curvature by 20,692 deg.

SOUTHEND CLOSES ITS PIER.—Southend pier was closed to the public on August 31st. Opened in 1835, it was purchased in May, 1875, for £12,000 by the Southend Local Board. In 1876 a horse tramway was built along it, and this was converted to electric traction by the late Col. R. E. B. Crompton's firm and opened in August, 1890, as "Crompton's Electric Railway." It was a 3ft. 6in. gauge single line laid with Bignoles rails, and current was conducted by a bare copper strip. In 1927 powers were obtained to double the track and install automatic signalling. As many as 3,000,000 persons normally used the pier every year in peace time, of whom 2,000,000 were customers of the electric railway.

TIME BOMB NEAR RAILWAY.—The courage of railwaymen in maintaining an essential service over a goods line, despite the known presence of unexploded time bombs, is reported by the L.M.S. Railway. After a raid it was discovered that unexploded bombs were buried near the line, in such a position that they would undoubtedly have done considerable damage had they gone off. Arrangements were made for a train of empty wagons to be stabled on one line, providing a screen between the bombs and two adjacent lines over which traffic was worked. When this had been done the whole of the staff concerned volunteered to a man to take the trains through, and the service was continued right through the danger period.

## Air and Water

SUBMARINE LOST.—The Board of Admiralty regret to announce that H.M. Submarine "Narwhal" (Lieut.-Commander R. J. Burch, D.S.O., R.N.) is overdue and must be considered lost.

MOSCOW TO KISHINEV AIR MAIL.—The Soviet Civil Aviation Fleet has instituted a daily air-mail service between Moscow and Kishinev (Bessarabia), *via* Kiev and Odessa. The planes being used on the new air line are of the PR-5 type.

FEWER SHIPS.—Ocean-going vessels passing through the Panama Canal during July numbered 431, compared with 485 for the corresponding month a year ago. The tolls collected from these vessels amounted to 1,735,553 dollars, as against 1,974,380 dollars.

NEWS FROM SWEDEN.—The Swedish shipping company Seva is reported to have put a ship into commission to carry on a service between Swedish ports and the Dutch port of Delfzijl, in the extreme north of Holland, *via* the Kiel Canal. A fortnightly service is indicated.

AERO-ENGINE ORDERS.—Pratt and Whitney have received an order for engines for the U.S. Army and Navy. The number is reported to be 17,000, and the cost about £40,000,000. The Wright Aeronautical Corporation also has received a similar order for 20,000 engines. An order for 600 Hawker Hurricanes has, it is reported, been placed with the Canadian Car and Foundry Company by the British Government. They will be built at Fort William, Ontario.

SOUTH FERGHANA CANAL.—The official opening took place recently in Russia of the South Ferghana canal. The new canal, 68 miles long, will not only irrigate the 130,000 acres of cotton fields of the Uzbekistan collective farms, but will also serve to reclaim 375,000 acres of desert lands, of which 125,000 acres will be sown to cotton this year. Like the Great Ferghana canal, the South Ferghana canal was built by local farmers. All the work—the excavation of 79¼ million cubic feet of earth, as well as the construction of 70 major and nearly 100 minor technical structures—was completed by the 50,000 canal builders in thirty days.

A BLACK LIST OF SHIPS.—An announcement by the Ministry of Economic Warfare indicates that still further measures are being taken to tighten up Britain's blockade of the seas, and the navicert system of the control of cargoes. The Ministry has decided to revive a black list of ships which will specify certain ships as being undesirable from Britain's point of view. Any ship which appears on this list will not only be denied access to British control facilities, but will be unable to obtain a navicert. In future, whenever a shipowner is placed on the statutory list, a list of the names of his ships will also be included, which will have the effect of shutting him out of British sea trade. It is understood that the next statutory list to be issued by the Ministry of Economic Warfare will contain the names of a number of such ships.

## Miscellanea

RADIO TELEPHONES IN FIJI.—Communication in the Pacific has been improved by the inauguration of a wireless telephone service between the Fiji Islands and the New Caledonia–New Hebrides group.

A QUEBEC AMALGAMATION.—The Quebec Provincial Electricity Board and the Quebec Transportation and Communications Commission have been merged to form a new Quebec Public Service Board.

NEWFOUNDLAND DEFENCE.—One million dollars is to be spent on defence work in Newfoundland, and Canadian contractors who have been active in Newfoundland in the past hope to get a share of the business.

NEW MAPS OF THE U.S.S.R.—A new political and administrative map of the U.S.S.R. is to be issued by the Department of Geodesy and Cartography under the Council of People's Commissars of the U.S.S.R.

A BIG COPRA PLANT.—Plans have matured for a copra pressing plant to be constructed in Vancouver. It will have a capacity of 1500 tons of copra a month, turning out 900 tons of cocoanut oil and 600 tons of copra meal.

OLD STEEL PLANTS IN THE U.S.S.R.—The iron and steel industry in the south of the Soviet Union is embarking on an extensive programme for the modernisation of old steel plants, with a view to bringing them into line with modern practice in the industry. Twelve large open-hearth furnaces in southern plants are to be made completely automatic, while thirty-eight will be partially equipped with automatic apparatus.

AN UNUSUAL JOB.—A 50-ton scaffold reaching to the seventh floor of a building in Montreal was moved recently from the front in one street to a similar position round the corner. This scaffold unit is complete with water hose, electric light equipment and a 1-ton hoist. The walls of the building were being bricked and repaired, and as the work progressed, it was necessary to move the scaffold without dismantling.

MONEY FOR BENEVOLENCE.—The North-East Coast Institution of Engineers and Shipbuilders is making an appeal for contributions to its Benevolent Fund. Shortly before the war the Council accepted gifts of £100 each from two prominent members for the purpose of initiating a Benevolent Fund. Since then donations from companies and members to whom the formation of the fund had become known has resulted in a nucleus of £1750.

WOOD FOR TOWERS.—The use of ultra-high frequency for radio beams began in Australia, where beams were installed on the air routes connecting Brisbane, Sydney, Melbourne, Hobart, and Adelaide. The transmitting aerials, short metal rods, were mounted on steel towers, but a year's experience has shown that wooden towers are better, as the steel affected the efficiency of the signals considerably. The erection of the new towers has been begun.

USING UP RESERVES.—The annual report of the Glasgow Corporation gas department for the year ended May 31st, 1940, shows how serious was the coal shortage during the early stages of the war. During January and February approximately 60,000 tons had to be taken from stock and a further 4000 tons purchased from Durham collieries. There was a marked increase in activity at the department's four chemical works, due to the increased Continental demand for coal tar products following the stoppage of German exports.

AN INVENTORS' COUNCIL.—A special division of the National Inventors' Council, a U.S.A. body, is to be set up shortly to receive, catalogue and appraise electrical inventions submitted to aid in national defence. The council expects to establish permanent offices in the Commerce Department building in Washington in about six weeks to act as a clearing house for all civilian suggestions for improving defence weapons. Dr. William D. Coolidge, director of General Electric Research Laboratories, is the member of the council particularly interested in the electrical field.

HARVESTING SPECIAL CROPS.—Russian engineers are paying special attention to machines for harvesting special crops. A modified combine-machine can be used to harvest rice, millet, and buckwheat, in addition to rye and wheat. The experimental shops of the Lyubertsy Works and of the Institute for the Mechanisation of Agriculture in Moscow are working out machines for harvesting flax and next year mass production of flax combine-harvesters will be started there. Soviet designers have also produced a sugar beet combine, which digs under the beet root, pulls it out of the ground, frees it of earth, cuts the leaves, and prepares the root. A cotton-picking machine has also been designed, and the first models will be tested this year on the cotton fields of Uzbekistan, Azerbaijan, Tajikistan, Turkmenistan, and Kazakhstan.

IRRIGATION IN THE CHU VALLEY.—Two Central Asiatic Republics of the Soviet Union are building large irrigation systems to water more than 400,000 acres of land in the valley of the Chu River. Where the river flows along the border between the Kirghiz and Kazakh republics it drains an area of 4,200,000 acres. Kazakhstan is building a dam which will raise the level of the Chu River by from 6½ft. to 10ft., and two canals of an aggregate length of 51½ miles, to irrigate about 27,000 acres of cultivated fields and about 7500 acres of what is now waste land. This work will be completed during the present year. Work on a still larger scale is being carried out in Kirghizia. The great Chu Canal, 125 miles in length, and a reservoir of over 17,657 million cubic feet capacity, will be constructed. When the river is in flood, the reservoir will fill up with water, which will be used in the summer months. In addition to the dam, the scheme includes the building of a number of aqueducts and sixty bridges.

CANADIAN STEEL.—The Western Steel Products Corporation, Ltd., an important Canadian concern, reports a wide improvement in gross and net earnings. Sales for the first six months of the year were 65 per cent. higher than those for the corresponding period of last year.

ELIMINATING THE ELECTRICAL FURNACE.—The Soviet Nitrogen Institute claims to have succeeded in producing calcium carbide in a large pilot plant without the use of the electric furnace. No details are available other than a statement indicating that ordinary blast-furnaces are suitable for the production of calcium carbide with a by-product of high-grade ferro-silicon and a fuel gas suitable for ammonia synthesis, methanol, or synthetic motor fuels.

INDIA TO SUPPLY IRON AND STEEL.—The Government of India has informed the British Government that India can meet the present steel demands from the Middle East, Iraq, Kenya, and Uganda, and that a monthly balance of 10,000 tons of untested light steel products and the same quantity of scrap will be available for Great Britain for the next twelve months. Arrangements have also been completed for shipping pig iron and foundry iron to Great Britain at the rate of 50,000 tons a month.

FATIGUE STRENGTH OF SCREW THREADS.—Writing in *Iron Age* on "The Effect of Method of Manufacture on the Fatigue Strength of Screw Threads," Mr. A. M. Smith concludes that cut threading has no apparent effect upon the physical properties of the original material and the endurance limit is about 30 per cent. of the ultimate tensile strength. Single extruding and rolling threads increases the ultimate tensile strength and endurance ratio, while decreasing the tension impact strength slightly. Double extruding and rolling threads increases the ultimate tensile strength and the endurance ratio the most and reduces the tension impact strength the most. Comparison with other investigations indicates that a round bottom thread has a higher ratio of endurance limit to ultimate tensile strength than the standard thread form with sharp corners at the bottom of the thread.

DRAINING WATERLOGGED ACRES.—Considerable progress is being made in dealing with Britain's waterlogged acres, especially in view of the wartime difficulties of providing materials and skilled men. Drainage schemes come under three heads:—The Catchment Boards, that deal with whole watersheds and know no county boundaries; the Drainage Boards and County Councils, concerned with local schemes; and the County War Agricultural Committees, whose province is ditches and field drainage on the farms. Twenty schemes from Catchment Boards, under the Miscellaneous War Provisions Act of 1940, have been approved this year, and seven other schemes had been submitted to the Ministry up to the end of August. This is additional to the 127 schemes prepared by Catchment Boards and approved by the Ministry for grant under the 1930 Land Drainage Act. They involve expenditure of approximately £13,300,000.

## Personal and Business

MR. ERIC V. BOWATER has been appointed by the Minister of Aircraft Production to take charge of the salvage of all crashed aircraft.

THE COPPER DEVELOPMENT ASSOCIATION informs us that it has now removed its offices, formerly in Thames House, to Grand Buildings, Trafalgar Square, London, W.C.2. Telephone, Abbey 2677.

THE STAVELEY COAL AND IRON COMPANY, Ltd., informs us that as from Monday, September 23rd, the address of its Glasgow office has been Kennyhill Goods Depot, L.M.S. Railway, Cumbernauld Road, Glasgow (telephone No., Provanmill 4488).

MR. GEORGE CLEMENT JENKS, M.I. Mech. E., chairman and managing director of the British Tool and Engineering Company, Ltd., Wolverhampton, has been appointed Director of Hand Tools in the Department of the Director-General of Equipment and Stores, Ministry of Supply.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, Ltd., of Dorking, informs us that Mr. E. J. Vidler has been appointed deputy sales manager. He entered the company's service in August, 1918, was appointed personal assistant to the sales manager in April, 1932, and assistant sales manager in May, 1937.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Institute of Fuel

*Tuesday, October 8th.*—Connaught Rooms, Great Queen Street, London, W.C.2. "Some Thoughts on Coke," W. Boon. 2.15 p.m.

*Thursday, October 17th.*—Connaught Rooms, Great Queen Street, London, W.C.2. Presidential Address, W. M. Selvey. 2.15 p.m.

### Institution of Automobile Engineers

*Tuesday, October 8th.*—COVENTRY CENTRE: King's Head Hotel, Coventry. "Bearing Metals and their Suitability for Modern Requirements," M. Melhuish. 7 p.m.

*Wednesday, October 9th.*—MANCHESTER CENTRE: The Engineers' Club, Manchester. Mr. Melhuish's paper will be repeated. 7.30 p.m.

### Institution of Structural Engineers

*Saturday, September 28th.*—YORKSHIRE BRANCH: Hotel Metropole, Leeds. Chairman's Address, R. H. Evans. 2.30 p.m.